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## Original Communications

### THE DIAGNOSIS AND OPERABILITY OF BRONCHIOGENIC CARCINOMA

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CARCINOMA of the stomach was responsible for more deaths during the year 1944 in the United States than carcinoma of any other organ.[13] Carcinoma of the respiratory system was exceeded only by carcinoma of the stomach, of the uterus, and of the breast as a cause of death.

The history of the surgical therapy of carcinoma of the stomach is more than twice as long as that of carcinoma of the lung. The five-year survival rate following operation is, nevertheless, very similar in the two conditions. For the stomach it has been reported as 19 per cent by Lawrence,[7] 27 per cent by Custer,[3] and 24 per cent by Walters.[14] For the lung, Ochsner and DeBakey[9] report 22 per cent five-year survivals and Rienhoff[11] 23 per cent. These figures still leave room for improvement. Such improvement will probably be accomplished by more prompt and certain diagnosis, by the exploration of some cases formerly considered inoperable, by a more radical operation, and by a reduction in the postoperative mortality. These aspects will be discussed in the light of experience gained from a study of fifty-six consecutive cases of primary bronchiogenic carcinoma, seen at the Jefferson Hospital during the past fourteen months (April, 1946, to May, 1947, inclusive).

#### DIAGNOSIS

Earlier diagnosis, and, consequently, earlier treatment, should improve the results of therapy of malignant disease. Early diagnosis is dependent upon

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Because of an error this paper was omitted from the group of papers presented at the symposium on cancer of the lung which were printed in the preceding issue of the JOURNAL. Some of the discussion, therefore, which concerns this paper will be found in the June issue of the JOURNAL.

—EDITOR

education of the public in the recognition of premonitory symptoms and upon the education of the general practitioner who first sees the patient. Thus an analysis of the symptoms presented by groups of patients with cancer of the lung is of value. There were fifty male and six female patients in our series. The youngest patient was 41 and the oldest was 75 years old. Twelve patients were in the fifth decade of life, eighteen in the sixth, twenty-one in the seventh decade, and five patients were over 70 years old. The symptoms first complained of are illustrated in Fig. 1. Cough was the most frequent first symptom. This was also true in Lindskog's series.[8] Often, however, the initial symptoms are due to occlusion of a bronchus by the tumor, with infection distal to the point of obstruction. The symptoms persist and the family doctor frequently makes a diagnosis of virus pneumonia. A diagnosis of virus pneumonia, or unresolved pneumonia, in males between the ages of 40 and 70 years should not be made without carefully excluding the possibility that a carcinoma of the lung may be responsible for the symptoms. The third most common initial symptom in our series was pain in the chest. This is often no more than mild discomfort but it is surprising how frequently a patient is able to localize the site of the primary lesion by a deep-seated pain in the chest.

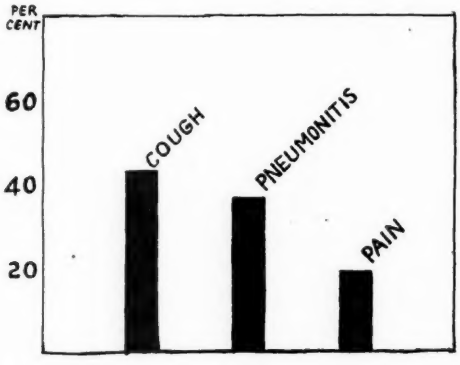


Fig. 1.—Graph of first symptoms.

Fig. 2 is a graph of the frequency of all symptoms complained of. This frequency is very similar to those reported in larger series of cases.[9, 11] The cough was usually unproductive at first. By the time the diagnosis was established, 80 per cent of the patients were bringing up some sputum. The amount expectorated, however, was usually very small. More than one-half the patients had hemoptysis. Weight loss and dyspnea were of equal frequency, and occurred in one-half of our patients. Rienhoff observed weight loss in 40 per cent of his patients, while Ochsner and DeBakey noted a significant loss of weight in 80 per cent of their patients. It is a symptom which is present in pulmonary carcinoma more often than is generally realized. Unilateral wheeze is of considerable diagnostic significance because it is almost invariably the result of a lesion producing some degree of bronchial obstruction. Two of our patients were

studied and treated for many months for bronchial asthma. Both these patients exhibited a unilateral wheeze which should have made the attending physician suspicious of a localized bronchial lesion.

X-ray of the chest showed some abnormality in all of Reinhoff's 327 cases. In Ochsner and DeBakey's series a diagnosis of carcinoma was made in 81 per cent of their patients on the basis of the x-ray findings, and in every case there was some alteration of the normal roentgenographic appearance. However, there may be an occasional patient in which x-ray examination of the chest is completely negative. We had the opportunity to observe one such patient. This

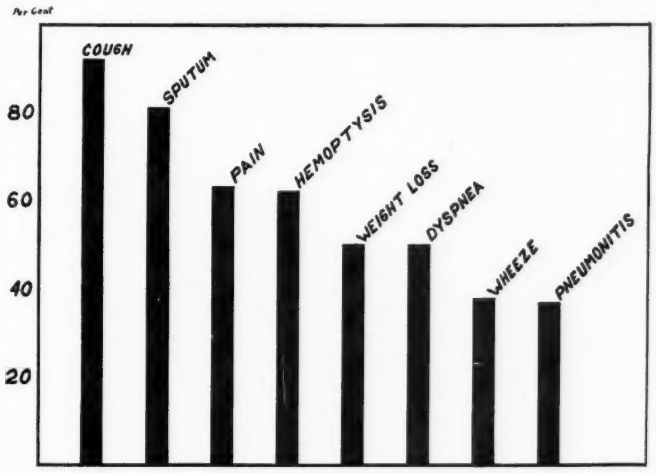


Fig. 2.—Graph of frequency of symptoms.

man, 55 years of age, was referred to one of us (L. H. C.) because of a persistent cough. X-ray of the chest was negative (Fig. 3.) He was bronchoscoped, and a growth was found extending into the left main bronchus. A biopsy was performed and squamous cell carcinoma found. As there were no physical signs or x-ray changes, we were completely dependent upon the bronchoscopic findings to determine which side of the chest to explore. The left side of the chest was opened. Nothing abnormal was noted in the lung except a slight thickening of the structures in the hilum. A left pneumonectomy was performed almost entirely upon the basis of the bronchoscopic report. On section of the lung a bronchogenic carcinoma was revealed which did not quite produce bronchial occlusion (Fig. 4). If the patient had not been operated upon, changes in the x-ray appearance of the lungs would have certainly occurred soon, as a result of bronchial obstruction.

The only way of making a positive diagnosis of bronchiogenic carcinoma prior to operation is by microscopic examination of a piece of the tumor. A portion of the tumor can be obtained by aspiration through a needle inserted through the chest wall into those growths which are peripherally located. There

have been two reported instances in which the tumor has been implanted into the chest wall at the site of the needle puncture.[9] This method of biopsy was not employed in any of our cases. The only other method of obtaining a portion of the tumor for microscopic study is by bronchoscope. All of our cases have

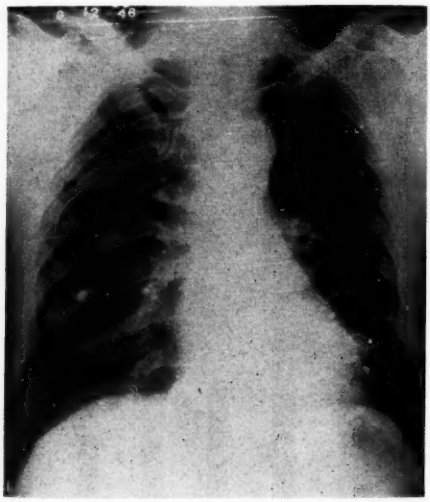

Fig. 3.—X-ray of the chest immediately preceding pneumonectomy in Case 9. No evidence of lesion in left lung.

Fig. 4.—Cross-section of left lung in Case 9. Carcinoma can be seen extending into both upper and lower lobe bronchi.

been bronchoscoped routinely. If the tumor cannot be seen, other suggestive evidence of neoplasm may be observed, such as narrowing, distortion, or fixation of the trachea or bronchus.

In 1946 two of us (P. A. H. and L. H. C.) described a method of diagnosing bronchiogenic carcinoma by the cytologic study of bronchoscopically removed secretions.[2, 4, 5] This method is believed to be superior to the cytologic examination of sputum. It is particularly useful where the tumor is located in the upper lobe or in the periphery of the lung. Secretions are aspirated through a bronchoscope from the bronchus draining the region of the suspected tumor. The material thus obtained is smeared on glass slides and stained by the Papanicolaou technique.[10] In the past six months the technique has been improved. When secretion cannot be obtained from the bronchus 2 to 5 c.c. of salt solution are introduced into the bronchus and then aspirated. The salt solution is then examined by the same technique as the bronchial secretions. One hundred eighteen consecutive cases of carcinoma of the lung have now been studied by this method (Table I). Neoplastic cells were found in approximately 90 per cent of these cases. In the same group a positive biopsy was obtained by the bronchoscope in approximately 45 per cent. Neoplastic cells were found in 43 cases in which the bronchoscopic examination was completely negative.

TABLE I. BRONCHOSCOPIC DIAGNOSIS IN 118 CASES OF CARCINOMA OF THE LUNG

| | NUMBER | PER CENT |
|---|---|---|
| Positive biopsy | 52 | 44 |
| Other suggestive bronchoscopic evidence | 23 | 20 |
| Neoplastic cells found | 105 | 89 |
| Neoplastic cells found; bronchoscopy completely negative | 43 | 36 |

Table II represents the experience of the senior author with these diagnostic methods in thirty-one patients with carcinoma of the lung explored in the past fourteen months. In eighteen patients a positive diagnosis was made before operation by biopsy obtained through the bronchoscope. In fifteen of these eighteen patients the bronchial secretions were also examined and neoplastic cells found in every instance. In nine patients in whom no biopsy could be obtained, neoplastic cells were found. In these nine patients, almost a third of those explored, the study of the bronchial secretions resulted in positive morphologic diagnosis prior to operation (Fig. 5).

TABLE II. BRONCHOSCOPIC DIAGNOSIS IN 31 PATIENTS EXPLORED

| | NUMBER | PER CENT |
|---|---|---|
| Positive biopsy | 18 | 58 |
| Neoplastic cells but no biopsy | 9 | 29 |
| No neoplastic cells and no biopsy | 4 | 13 |

## EXPLORATION

There will always be some patients in whom a diagnosis of pulmonary carcinoma cannot be definitely established without exploration. This was true of four of our thirty-one patients (Table II). In two of these the lesion was resectable and in the other two it proved to be too far advanced for removal. All

four had peripheral lesions, two in the right upper lobe and one each in the right lower and left lower lobes. It cannot be too strongly emphasized that every effort should be made to obtain a positive diagnosis before operation. Without such a diagnosis it may be very difficult to determine by inspection or palpation at operation whether or not one is dealing with a malignant tumor. Furthermore, biopsies obtained at the time of operation may fail to reveal tumor tissue, even though a malignant tumor is present. This was illustrated by one patient in our series. He had recovered from an attack of pneumonia, but a residual area of increased density in the left upper lobe could be seen on the roentgenograms. The patient had no symptoms. Bronchoscopic examination was entirely negative, but neoplastic cells were found in saline washings from the left upper lobe bronchus. At operation the medial half of the left upper lobe was firm to palpation. The firmness might well have been due to some chronic inflammatory process. To confirm the diagnosis a biopsy was taken from this area of the upper lobe. Only chronic inflammatory tissue was seen in the microscopic section. A pneumonectomy was performed and a carcinoma found on section of the upper lobe. The biopsy had evidently been taken from the inflammatory tissue around the periphery of the tumor. The finding of neoplastic cells in the salt solution washings was of considerable help in making the decision to perform a pneumonectomy.

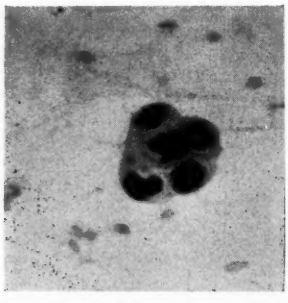

Fig. 5.—Photomicrograph of a group of five cancer cells seen on a smear obtained from the salt solution washing of a bronchus. A biopsy could not be obtained. The patient was explored and a pneumonectomy performed.

Where the diagnosis is certain we feel that exploration should be performed in all patients, unless there is unequivocal evidence of extension of the disease beyond the hemithorax in which the tumor lies, or unless a pleural effusion exists which is bloody, or contains malignant cells. This more radical approach is becoming more generally accepted.[9] The older and more conservative attitude is to refuse operation to patients with *any* type of pleural effusion, those with continuous pain referred to the shoulder or down the arm, or those with Horner's syndrome, left recurrent laryngeal or phrenic nerve palsy.[11] A still more conservative view holds that a lesion is inoperable because of the x-ray appearance.[8] The really debatable issue, concerning whether or not exploration should be done, lies in the group with nerve palsies. Certainly involvement of the

phrenic, recurrent laryngeal, or sympathetic nerves indicates an infiltrating growth which has extended beyond the confines of the lung. This does not mean, however, that the lesion cannot be removed by block dissection including the involved nerve. The phrenic nerve was resected in two of our patients, and the vagus nerve in one. One pneumonectomy was done in which there was a contralateral Horner's syndrome, but no other evidence of involvement outside the hemithorax. This patient died five months after operation. He had extensive metastasis to the right ilium and to the fifth cervical vertebra, which resulted in a pathologic fracture, quadriplegia, and death in twenty-four hours. Probably this patient should not have been operated upon.

In thirty-seven of 243 carefully studied patients with recurrent laryngeal nerve paralysis, no demonstrable cause for the condition could be found.[12] Because of this fact, we have not felt justified in refusing exploration on account of such a paralysis of the vocal cords. Oehsner[9] performed a pneumonectomy on a patient with a palsy of the recurrent laryngeal nerve, and the patient survived operation three years. We have explored one patient with a recurrent laryngeal nerve paralysis, who proved to have an unresectable lesion.

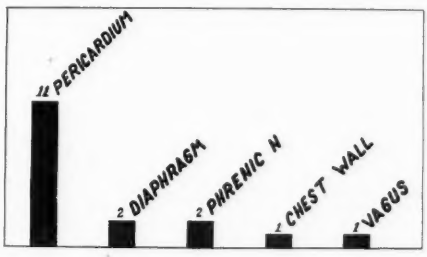


Fig. 6.—Graph of additional resections performed in conjunction with pneumonectomy.

## RESECTION

When the chest is opened, the decision to perform a pneumonectomy must be based upon the same principles of cancer surgery which obtain elsewhere. If all visible and palpable tissue involved by the growth can be removed en masse, without leaving any evident malignant tissue behind, we believe that a radical pneumonectomy should be done. The procedure which we have found most effective in increasing resectability has been the intrapericardial ligation of the pulmonary vessels, as proposed by Allison.[1] In eleven of the twenty pneumonectomies performed in this series intrapericardial ligation of the hilar vessels was performed. In ten of these patients it would have been impossible to remove the lung by any other means. In the eleventh patient, because of the proximity of the growth, it was technically more feasible to perform intrapericardial ligation. In four of the ten patients in whom intrapericardial dissection was necessary, the growth was in the left main bronchus, in two it was in the left lower lobe, in three in the right lower lobe, and in one the right middle lobe. In none of the four patients in whom the growth was primarily in the

TABLE III. INCIDENCE OF OPERABILITY, RESECTABILITY AND OPERATIVE MORTALITY REPORTED IN 1947

| AUTHOR | YEARS COVERED | NUMBER CASES OBSERVED | CASES EXPLORED | | CASES RESECTED | | OPERATVE MORTALITY IN RESECTED CASES (%) |
|---|---|---|---|---|---|---|---|
| | | | NUMBER | PER CENT | NUMBER | PER CENT OF EXPLORED | |
| Ochsner and DeBakey | 10 | 360 | 210 | 58 | 129 | 61 | 20* |
| Rienhoff | 13 | ? | 327 | ? | 112 | 34 | 21† |
| Jones | 4 | 196 | 66 | 31 | 39 | 59 | 5 |
| Gibbon et al. | 1† | 56 | 31 | 55 | 21 | 68 | 10 |

*In last five years.
†In last six and one-half years.

upper lobe was intrapericardial dissection necessary. The usual indication was involvement of either the superior or inferior pulmonary vein by the growth, or invasion of the pericardium itself. Fig. 6 shows the other structures which required removal in order to resect the growth completely. In one of the patients in whom the diaphragm was involved, almost half of this muscle had to be removed because of direct extension by growth. In every case all visible and palpable mediastinal lymph nodes were removed. The nodes removed included not only those along the main bronchus of the involved lung, but also the tracheal nodes, and frequently the glands along the inferior margin of the contralateral bronchus. Removal of a portion of the pericardium and ligation of the pulmonary veins at their junction with the left auricle are simple procedures to carry out, and should increase the percentage of pneumonectomies in the patients explored (Table III).

### POSTOPERATIVE MORTALITY

The postoperative mortality in recently reported series is shown in Table III. This mortality has shown an encouraging decline in recent years. The lowest mortality has been reported by Jones,[6] who in an addendum to his article, states that he has performed fifty-two pneumonectomies for carcinoma of the lung with only two hospital deaths, an operative mortality of slightly under 4 per cent. We have performed twenty-one resections for primary pulmonary malignancy. Twenty of these resections were pneumonectomies and one was a partial removal of the right lower lobe. The latter operation was for a circumscribed, encapsulated lesion which proved to be malignant on later microscopic study. Two patients died in the hospital following operation. One death occurred shortly after pneumonectomy from a tension pneumothrax. An unsuccessful attempt was made to control this condition by suction through a catheter. The other patient died five weeks after pneumonectomy. He developed an empyema with a bronchopleural fistula, which required open drainage. This was the only empyema in our series. Open drainage was established and the patient's temperature was normal for two weeks prior to death. However, the patient showed progressive weakness and loss of appetite. At autopsy extensive metastasis to both adrenal glands was found. This undoubtedly contributed to the fatal termination. There have been five late deaths from exten-

sion of the disease, from three to nine months after operation. Improvement in the care of the patient during and after operation will undoubtedly contribute to a further lowering of the mortality.

## CONCLUSIONS

1. Examination of the secretions or saline washings from the bronchus suspected of being the site of a malignant growth will increase the percentage of correct diagnoses prior to operation.

2. The contraindications to exploration are unequivocal evidence of metastatic extension beyond the hemithorax which is the site of the tumor, or the presence of blood or tumor cells in a pleural effusion on the affected side.

3. The limits of operability can be extended in many instances by opening the pericardium and ligating the pulmonary veins flush with the left auricle.

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# THE TREATMENT OF INOPERABLE BRONCHIOGENIC CARCINOMA WITH METHYL-BIS

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THORACIC surgeons would be among the first to agree that surgery will never be the complete answer to the cancer problem. Even the combination of an alert medical group and an intensive educational program in the lay public will not diagnose all cancer early enough to be curable by surgery. Particularly is this true in bronchiogenic carcinoma. Early surgery in this form of cancer offers good hope for cure. However the majority of patients seen are still in the far-advanced stage in which surgical cure is not possible.

X-ray therapy in bronchiogenic carcinoma is chiefly palliative in its action. Recently, however, I have been privileged to see the rough draft of a paper from one of the well-known cancer research hospitals in this country. In this report they list over 400 patients treated by x-ray therapy for cancer of the bronchus. In this group they have several patients alive seven, eight, ten, and even thirteen years after the diagnosis was established and x-ray treatment instituted. Such results following x-ray therapy are the exception rather than the rule.

Because the group of patients with bronchiogenic carcinoma for which surgery offers no hope of cure is so large, a search has been made for some drug which would help in the treatment of these unfortunate patients. I would like to report our results with one of these drugs. We have only been working with the drug for a period of one year, so this will be of necessity a preliminary report and I am sure some of our conclusions will have to be modified later.

Methyl-bis (B-chloroethyl amine hydrochloride) is one of the nitrogen mustard derivatives. During the war the Army Chemical Service experimented with over 300 such mustard gas compounds in its search for effective war gases. Methyl-bis is the first of these derivatives which has been released for widespread investigational use. Its therapeutic efficiency is based upon its remarkably toxic action on rapidly growing cells. Thus its action is first upon rapidly growing cancer cells and second upon the bone marrow. Other toxic effects have not been observed as yet in many patients.

The aim of treatment, therefore, is to administer enough of the drug to stop the growth of the carcinoma cells and yet not enough to depress the bone marrow too much. The drug is extremely toxic and only minute doses can be used. The margin of safety between the therapeutic dose and the toxic dose is very small, so that each patient must be followed very carefully.

Other drugs in this mustard group are under analysis and investigation at the present time and we are hoping that one of these other drugs may be even more effective therapeutically and less toxic to the normal body cells.

Read at the Twenty-Seventh Annual Meeting of The American Association for Thoracic Surgery, St. Louis, Mo., May 28, 29, and 30, 1947.

Methyl-bis has been used experimentally since 1942 in treating various types of cancer, chiefly of the Hodgkin's disease and lymphatic group. It is only in the last year that much work has been done in bronchiogenic carcinoma. At the present time 126 different hospitals and clinics in the United States are using Methyl-bis experimentally in various forms of cancer. However, only two series of cases of any size have been reported as yet using Methyl-bis in the treatment of cancer of the bronchus. One of these groups was studied at Memorial Hospital in New York, N. Y., and the other group by us in Memphis, Tenn.

Today I am presenting only our own cases for discussion, but in the future the collected cases from all these institutions will be gathered together in one paper and submitted to the *Journal of the American Medical Association* for publication.

Thus far this work with Methyl-bis has been done under the auspices of the National Research Council's Committee on Growth, headed by Dr. Cornelius Rhoads at Memorial Hospital in New York, and the drug must still be obtained through his office. However it is possible that in the near future the drug will be placed on the market. There is one grave danger in placing such a drug on the market. When cancer can be treated by shots such as Methyl-bis, there will be a temptation with some physicians to use the drug incorrectly. That is, to use it in cases which are suitable for surgical cure. Its use in these cases would only spell disaster for the patients and delay surgery until cure is no longer possible. Therefore, when the drug is distributed for sale we believe the accompanying literature should specifically state that *the drug is not curative* so far as we know, that its effect is only temporary, and that surgery so far offers the only possibility of curing bronchiogenic carcinoma. Its use should be specifically recommended for cases which are not suitable for surgical cure, that is, patients with positive evidence of metastases or direct extension into the mediastinum.

I would like to express one of my conclusions at this point and then justify this conclusion. Methyl-bis is definitely helpful in treating cases of inoperable bronchiogenic carcinoma and it gives clinical improvement in about 70 per cent of such cases for periods of time ranging from six weeks up to six months, after which time the drug must be repeated. The most effective results are secured with the first course of treatment with the drug. Subsequent courses of treatment do not give such noticeable clinical improvement and eventually the drug becomes ineffective.

Up to the present time a total of 500 patients in the United States have been treated with Methyl-bis for various forms of cancer. Of this large group of 500 cases, only forty are reported on bronchiogenic carcinoma in enough detail to justify discussion, and of this forty I would like to present seventeen of our proved cases. The drug is furnished free of charge by Merck and Company at the present time with the stipulation that all cases must be reported in detail to the Committee on Growth of the National Research Council. Because of the extreme care used so far in administering the drug, no serious toxic manifestations have occurred. When these cases are followed with serial x-rays, it is

often observed that the tumor becomes stationary for a time and then slowly resumes its growth. It is rare indeed to note any diminution in the size of the tumor following Methyl-bis, but a few such cases have occurred. The drug was tried in all the various histologic classifications of carcinoma of the lung and there did not appear to be much difference in response among the various types of carcinoma of the bronchus. A few such cases which showed little or no improvement after x-ray therapy were definitely benefited by Methyl-bis. The earlier cases in our series were treated by Methyl-bis alone. Later, laboratory work suggested that a combination of Methyl-bis followed by x-ray therapy might be more effective than the Methyl-bis alone. For this reason, the later patients in our series were treated by a combination of Methyl-bis and x-ray therapy. As you can see in our figures, however, this laboratory suggestion was not borne out by clinical data. That is, the patients receiving Methyl-bis alone did as well as those receiving the combination of Methyl-bis and x-ray therapy. As a matter of fact, weight gain was noticed more in the group receiving Methyl-bis alone than in those receiving x-ray therapy and Methyl-bis together. Just as arsenic and bismuth combined appear to be more effective in the treatment of syphilis than either drug alone, so it was reasoned that the combination of x-ray therapy and Methyl-bis would prove more effective than either alone in bronchiogenic carcinoma. This still may be the case, but our early results do not bear this out. It is entirely possible that in our own series we have been using inadequate amounts of Methyl-bis. However, we felt that for a year it would be advisable to adhere to one dosage schedule. Next year we plan to increase the dosage and see the difference in therapeutic results.

At Memorial Hospital they have noticed no difference in results so far in those receiving the standard dose of Methyl-bis as compared with patients receiving double this dose. When the dose is doubled severe bleeding tendencies may occasionally occur. Methyl-bis causes considerable relief of pain in the majority of these patients, but when the pain is severe, x-ray therapy seems to be more effective than the Methyl-bis in relieving the pain. It is possible that the Methyl-bis, or the combination of Methyl-bis plus x-ray therapy causes a definite prolongation of life in these patients. However, the study is too recent to justify such a conclusion as yet. The early results point in this direction.

We do feel that the majority of the patients so treated gain in weight and strength and are able to continue working until nearly the terminal stage of the disease. The end usually comes rather rapidly and it has been very encouraging to us to note that only rarely are narcotics required in the patients treated with Methyl-bis.

Our policy during the coming year will be to administer as much Methyl-bis as the bone marrow will tolerate, as judged by repeated serial blood counts, and to administer as much x-ray dosage as the skin will tolerate.

Following the Methyl-bis injections, over half of the patients exhibit varying degrees of nausea, vomiting, and anorexia which occur a few hours after the administration of the drug and may continue for twenty-four hours. However, this nausea and vomiting are transient and stop when the drug is stopped.

The drug has several advantages over x-ray therapy. It can be produced fairly cheaply and can either be administered as an office procedure or the patient may be hospitalized for a period of four or five days during its administration. It can be used in cases with such widespread metastases that x-ray therapy is of little use. The nausea and vomiting associated with Methyl-bis are usually of shorter duration than the same symptoms following x-ray therapy. We have found that the use of 100 mg. of pyridoxine hydrochloride hypodermically will reduce the incidence of nausea and vomiting. The pyridoxine is usually administered early in the morning and the Methyl-bis is given later in the day.

The results obtained in treating Hodgkin's disease and the lymphatic carcinomas with Methyl-bis are much more dramatic than the results obtained in treating bronchiogenic carcinoma. Our own method of administering the drug thus far has been as follows:

### METHYL-BIS TREATMENT ROUTINE

A well-balanced diet with a wide variety of foods, which should include one quart of milk daily and one generous serving of meat, fish, or eggs with each meal. Amino acids orally are prescribed if indicated. One multiple vitamin capsule is given twice a day and one ferrous sulfate tablet after each meal and at bedtime. Smoking is prohibited. Many of these patients have an associated bronchiectasis due to the carcinoma and the symptoms of the bronchiectasis are usually helped when the smoking is stopped. A postural drainage routine is helpful in such cases. Aspirin will usually suffice for discomfort or actual pain in most cases. Daily sun baths are advised when the weather permits to keep the patient busy and also for the mild tonic effect. Incidentally, the sun baths seem to be a morale builder as well. Moderate exercise and recreation are helpful but the patient is advised to avoid overfatigue. He may work if he feels able.

A follow-up history, physical examination, complete blood count, and either fluoroscopic or x-ray examination of the chest is taken every two weeks. Blood transfusions are used if indicated, as the Methyl-bis is quite toxic to the bone marrow. However, using the dosage recommended, blood transfusions are only necessary in 10 to 20 per cent of the patients treated.

### ADMINISTRATION OF METHYL-BIS

The drug is supplied in 10 mg. vials as a dry powder. The patient is hospitalized for five days and is given 0.1 mg. of Methyl-bis per kilogram of body weight intravenously once daily for four days. This course of treatment can be repeated every two or three months or more often if necessary. The drug must be used immediately after it is made up in solution. Ten cubic centimeters of sterile saline are injected into the 10 mg. vial of Methyl-bis and the appropriate amount of drug is withdrawn and injected. The vial is then discarded. Immediately following the Methyl-bis injection the needle is left in place and another syringe containing 10 c.c. of sterile saline is then injected through the same needle in an attempt to prevent thrombosis in the vein.

A still better method of administration is to start 1,000 c.c. of sterile saline going intravenously and then inject the appropriate dose of Methyl-bis into the tubing with a No. 22 gauge needle.

Lately we have treated some patients by giving one dose of the Methyl-bis every two weeks, and apparently have obtained similar results as with the foregoing method. By giving the drug once every two weeks it can be given in the office without hospitalizing the patient. Larger doses than the above amount can be given but are more hazardous.

The action of the Methyl-bis on the cancer cells and on the bone marrow is in many ways similar to the action of x-rays. In the experimental animal and in human beings as well, larger doses result in a lymphopenia, a granulocytopenia, a thrombocytopenia, and a moderate anemia. These effects are directly porportional to the dosage of Methyl-bis given. Disappearance of mitotic activity is noted in both the bone marrow and in the cancer cells following the injection of Methyl-bis. Continued large doses of Methyl-bis cause a complete depletion of the bone marrow and eventual aplasia. Experimentally, it can be demonstrated that the Methyl-bis acts directly on the structure of the chromosomes and this abnormality in the chromosomes can be transmitted from ovum to ovum for several successive generations. So far as we know now the therapeutic efficiency of the nitrogen mustards is no greater than that of x-ray therapy.

## RESULTS

In all we have now treated thirty-one cancer patients with Methyl-bis. Twenty-five of these patients had bronchiogenic carcinoma. Of these, three were adenocarcinoma, five were squamous cell carcinoma and seventeen were undifferentiated cell carcinoma.

Although we have thus far treated twenty-five cases of bronchoigenic carcinoma with Methyl-bis, we are only reporting in detail seventeen of these cases in this report as only these seventeen have a definite pathologic report and follow-up study sufficiently complete to be of statistical interest.

In addition to these twenty-five bronchiogenic carcinoma patients, we have treated one patient each with carcinoma of the cervix, carcinoma of the esophagus, carcinoma of the ovary, adenocarcinoma of the testis, carcinoma of the nasopharynx, and melanosarcoma. Most of the patients in the above miscellaneous group had multiple pulmonary metastases, which is the reason they came to our attention.

Five of the six patients listed above with miscellaneous carcinoma elsewhere in the body received definite clinical improvement following the Methyl-bis administration, but again the improvement was only temporary and in a period of a very few weeks or months the tumors again showed signs of growth and further metastases then occurred. One rather striking case was that of an elderly man with two large tumors on the anterior chest wall, one on either side. The one on the right was completely excised surgically including the rib and parietal pleura involved. The pathologic diagnosis was a lymphosarcoma. As an enlarging tumor was then apparent in the abdomen further surgery

seemed useless. Methyl-bis was given and three days later the tumor on the left chest had completely disappeared. This tumor was approximately the size of half an apple.

Methyl-bis is a useful drug, but so far as we know is not curative. One indirect benefit from the drug is that these patients are observed more carefully and symptoms can be treated as they arise. This in itself helps in raising the morale of these patients who were formerly told to go home and that nothing else could be done for them. Another advantage of the Methyl-bis is that it is a powerful expectorant, and this action usually results in making the patient's breathing easier and in decreasing his wheezing. Some of these patients even spit up bits of the tumor during the administration of the Methyl-bis. Naturally, mortality statistics in this group of cases are not encouraging. If our diagnosis is correct, our eventual mortality will be 100 per cent.

## REPRESENTATIVE CASES

I would like now to present brief histories on four representative patients who were treated early in our series with Methyl-bis alone and who showed definite clinical improvement following the use of the drug.

CASE 1.—Mrs. B. F., aged 68, housewife, had a squamous cell carcinoma in the bronchus with metastases to both pleural spaces and to the seventh left rib. She had noticed palpitation for several years and during the past few weeks had noticed dyspnea, slight cough, and left chest pain. The hemothorax on the left was aspirated on numerous occasions and large amounts of bloody fluid were obtained. The fluid, when centrifuged, revealed cells suspiciously like cancer cells but the pathologist was unwilling to make a definite diagnosis on these few cells.

On Aug. 24, 1946, the seventh left rib was removed and pathologic examination showed definite squamous cell carcinoma. She was given 5.8 mg. of Methyl-bis intravenously on August 28, 29, 30, and 31 and she noticed repeated vomiting each time for one day following the injections. Two months later she was doing housework and felt well. Her breathing was comfortable, she had no fever, and she had gained five pounds in weight. Two weeks later she had gained another three pounds and her strength was improving.

On Nov. 11, 1946, 300 c.c. of clear amber fluid were aspirated from the left chest and since that time no more fluid has been present in the left chest. Several taps since then have yielded no fluid.

She was given a second course of 6.5 mg. of Methyl-bis on Dec. 7, 8, 9, and 10, 1946. Pyridoxine was administered this time and her vomiting was a little less than with the first course. The patient was in much better condition now than she was three months previously.

In January her general condition was still excellent and she was doing her housework but taking occasional aspirin for pain.

In March, 1947, she was given her third course of Methyl-bis. She received 6.5 mg. on Feb. 17, 19, 24 and March 10 and 29, 1947. At that time she weighed fourteen pounds more than she did when originally seen and she was still doing her own housework. No narcotics are required. She is still alive.

CASE 2.—Mr. D. F., aged 58, had pneumonia five times since childhood. The past twelve years he had been treated elsewhere for asthma. He had had a cough for several years and blood-streaked sputum intermittently the past few years with two severe hemoptyses, and he had also noticed shortness of breath during this time. During the past three years he had two typical attacks of coronary thrombosis. The past few months he had not worked.

In July, 1946, an x-ray showed a tumor in his chest. Indirect laryngoscopy revealed complete paralysis of the left vocal cord. Bronchoscopy that same month showed a tumor in the left upper lobe bronchus and in the left main bronchus. A biopsy of this tumor showed a squamous cell carcinoma of the bronchus, poorly differentiated. A ray fungus was also found in the bronchoscopic sputum, but this was not definitely identified as actinomycosis.

He was given 9 mg. of Methyl-bis intravenously on July 24, 25, 26, and 27, 1946. During the administration of the drug he raised much sputum and also coughed up bits of the tumor. He vomited a few times. Two months later he had gained ten pounds in weight and his sputum was decreasing and now clear. He was able to work half a day, managing a coal yard. There was no change in the size of the tumor during those two months. Three weeks previously he had a mild cerebral apoplexy but recovered with a slight residual weakness in the left arm and left leg.

A second course of Methyl-bis was given, 9.5 mg. being administered on Nov. 18, 19, 21, and 22, 1946. An x-ray at this time suggested that the tumor had shelled out a large central cavity 7 cm. in diameter.

In January, 1947, he weighed twenty pounds more than he did before Methyl-bis was started, and was working full time. He occasionally noticed blood streaking. In February he had constant dyspnea and had an hemoptysis of two or three ounces.

On March 11, 1947, his physical condition appeared surprisingly good considering the size of his tumor, and he was given another 9.6 mg. of Methyl-bis intravenously.

On April 21, 1947, he was admitted to the hospital with uremia. A few days later he fell out of bed and broke his hip and died quietly three days after this. No autopsy was permitted. His x-ray showed little change in the size of the chest tumor.

We believe that Methyl-bis probably prolonged his life and made him more comfortable. He was given an occasional Dilaudid tablet for his hemoptysis, but little medication was required for pain.

CASE 3.—Mr. H. B., aged 54, stated he had pneumonia several years ago, followed by flu. He had felt poorly since January, 1946; that is, he was weak, nervous, noticed easy fatigue, and had a moderate weight loss. He was put on an ulcer diet because of his stomach complaints. During the past several years he occasionally noticed blood-streaked sputum and some shortness of breath, with moderate cough and sputum.

X-ray in July, 1946, revealed a tumor in the right upper lobe with some increase in atelectasis, and he had several hemoptyses. A gastrointestinal series showed no pathology.

Bronchoscopy was performed on three separate occasions and each time involvement of the lower trachea, right upper lobe bronchus, and carina by an ulcerating lesion was seen. The first two bronchoscopic biopsies were indeterminate and sputum examinations were negative for acid-fast bacilli. We felt that if this were a carcinoma it was inoperable because of involvement of approximately one inch of the trachea. Hoping that it was a pulmonary tuberculosis, a right phrenic crushing was done on March 14, 1946.

The last bronchoscopy on July 17, 1946, enabled us to make a definite diagnosis, as the biopsy at that time revealed an undifferentiated bronchiogenic carcinoma. In addition, one sputum showed Monilia.

He received 6.9 mg. of Methyl-bis intravenously on July 22, 23, 24, and 25, 1946. He vomited once or twice. Four months later he felt better and stronger and had gained seven pounds in weight. No further hemoptyses had occurred. He was given three transfusions for a secondary anemia. A month later he noticed some weakness of his voice and indirect laryngoscopy revealed complete paralysis of the right vocal cord.

X-ray at this time showed some regression of the atelectasis and the tumor appeared smaller. In October, 1946, he received three more transfusions for his secondary anemia. He was constantly hoarse and wheezing and had some dyspnea on exertion, but he was ambulatory and gaining weight. He now weighed fourteen pounds more than he did before Methyl-bis therapy.

On Nov. 12, 1946, his voice was almost normal at times, he had gained three more pounds, and an x-ray of his chest showed a central softening of the tumor. A second course

of Methyl-bis was given. He received 7.2 mg. on Nov. 21, 22, 23, and 24, 1946, with pyridoxine earlier each day. Each time there was much less vomiting than with the first series.

In January, 1947, he began a rapid downhill course. He found it difficult to swallow, was short of breath, and lost five pounds in weight. Enlarged lymph nodes appeared about the right clavicle and a small right pleural effusion made its appearance. He died in February, 1947, with complete paralysis of both vocal cords. A tracheotomy had been performed, but this gave little relief. A bronchoscopy had been performed through the tracheotomy opening in an attempt to remove enough of the tumor from the left bronchus to give him an airway. Bleeding occurred and the patient asphyxiated soon after the bronchoscopy.

Autopsy was performed and a tumor was found at the carina, 15 cm. in diameter which extended up the trachea almost to the tracheotomy opening. This tumor completely occluded the right bronchus. There was extreme enlargement of the tracheobronchial lymph nodes and one metastatic nodule in the left adrenal gland. There was evidence of recent hemorrhage into the left bronchus.

This patient was relatively comfortable and gained in weight until one month before his death and only occasional codeine was required for discomfort.

CASE 4.—Mrs. E. M. B., 50 years old, had noticed a cough for the past nine years since a "strep throat" at that time. The cough was nonproductive, but worse the past year. There had been constant intractable pain in the right arm more recently.

In July, 1946, she noticed several kernals over her body and at our first examination we saw six of these nodules present. She had a low-grade fever and fluoroscopy revealed paralysis of the right diaphragm.

X-ray of the chest showed a lemon-sized tumor in the right paramediastinal region and excision of one of the nodes on her scalp revealed evidence of a metastatic bronchiogenic carcinoma.

Five milligrams of Methyl-bis was given intravenously Sept. 6, 7, 8, and 9, 1946. She vomited several times after each dose. The following months she gained a little weight. Her dyspnea was less and her wheezing disappeared. The pain was not as severe.

X-ray showed no growth in the bronchiogenic carcinoma and the metastatic nodes remained the same size. Radium needles were inserted in a metastatic nodule on the tongue and caused almost complete disappearance of this nodule. She was ambulatory.

Another course of Methyl-bis was given Nov. 4, 6, 7, and 9, 1946. At each injection she received 4.8 mg. of the drug with much vomiting after each dose. She is still alive and ambulatory part of the time and requires no narcotics.

In January, 1947, she had lost fifteen pounds since the original examination. She had a temperature of 99.4° F. in the afternoon, and she was up several hours a day but was weaker. The nodules over her body were larger. She required no opiates but took aspirin occasionally for pain and used a heat lamp.

TABLE I. SEVEN PATIENTS STILL ALIVE

| METHYL-BIS ALONE (2 EARLIER CASES) | | | METHYL-BIS PLUS X-RAY THERAPY (5 LATER CASES) | | |
|---|---|---|---|---|---|
| TYPE CARCINOMA | TIME SINCE BIOPSY DIAGNOSIS | TIME SINCE ONSET OF SYMPTOMS | TYPE CARCINOMA | TIME SINCE BIOPSY DIAGNOSIS | TIME SINCE ONSET OF SYMPTOMS |
| 1 squamous cell carcinoma (doing housework) | 9 mo. | 12 mo. | 1 squamous cell carcinoma (working) | 7 mo. | 4 yr. |
| | | | 3 undifferentiated type carcinoma working | 5 mo. | 6 mo. |
| 1 undifferentiated type carcinoma (doing housework) | 10 mo. | 20 mo. | Doing housework | 3 yr. | 3½ yr. |
| | | | Ambulatory | 3 mo. | 6 mo. |
| | | | 1 adenocarcinoma (doing housework) | 5 mo. | 17 mo. |

TABLE II. TEN PATIENTS WHO HAVE EXPIRED

| METHYL-BIS ALONE (5 EARLIER CASES) | | | METHYL-BIS PLUS X-RAY THERAPY (5 LATER CASES) | | |
|---|---|---|---|---|---|
| TYPE CARCINOMA | TIME SINCE BIOPSY DIAGNOSIS | TIME SINCE ONSET OF SYMPTOMS | TYPE CARCINOMA | TIME SINCE BIOPSY DIAGNOSIS | TIME SINCE ONSET OF SYMPTOMS |
| 2 squamous cell carcinoma patients | 9 mo.<br>5 mo.* | 12 yr.<br>2½ yr. | 1 squamous cell carcinoma patient | 7 mo. | 8 mo. |
| 3 undifferentiated type carcinoma patients | 7 mo.<br>7 mo.<br>5 wk.† | 13 mo.<br>2 yr.<br>2 mo. | 4 undifferentiated type carcinoma patients | 9 mo.<br>4 mo.<br>4 mo.<br>4 mo. | 2 yr.<br>10 mo.<br>7 mo.<br>6 mo. |

*Terminal coronary attack.
†Died five weeks after exploratory thoracotomy, with complicating hemothorax.

TABLE III. CLINICAL IMPROVEMENT (TEMPORARY)

| | METHYL-BIS ALONE (7 CASES) | METHYL-BIS PLUS X-RAY THERAPY (10 CASES) |
|---|---|---|
| Weight gain | 70% (4, 10, 14, 14 and 20#) | 40% (highest gain 7#) |
| Decrease or cessation of hemoptyses | 42% | 10% |
| Cessation of hemothorax | 14% | 10% |
| Clearing of atelectasis | 28% | 10% |
| Disappearance of congestive heart failure (only 1 pt. had this) | | 10% |
| Subsidence of pleural effusion (only 1 pt. had this) | | 10% |
| Decrease in cough, sputum, wheeze, and dyspnea | 70% | 60% |
| Decrease in sepsis (chills, fever, etc.) | 70% | 40% |
| Increase in strength and ambulation | 70% | 90% |
| Decrease in pain (only 1 required morphine terminally) | 70% | 70% (only 2 required morphine terminally) |

## CONCLUSIONS

We believe that the proper treatment of bronchiogenic carcinoma at the present time is pneumonectomy if at all feasible. If surgery is not warranted because of extension of the carcinoma into the mediastinum or of the presence of distant metastases, then we believe a combination of Methyl-bis injections plus x-ray therapy offers the best aid to the patients. Methyl-bis is a useful drug, but it is extremely toxic and it must be administered with care. Studies must be repeatedly made on the patient's blood to follow the state of the bone marrow. When the drug is placed on the market for sale we strongly advise that the literature accompanying the drug state explicitly that surgery is still the only curative therapy in bronchiogenic carcinoma and that Methyl-bis should be reserved for cases not suitable for surgical attack.

We would like to express our sincere thanks at this time for the wholehearted cooperation and advice given us by Dr. Cornelius P. Rhoads and Dr. David Karnofsky of Memorial Hospital in New York City.

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## DISCUSSION

DR. MICHAEL E. DEBAKEY, New Orleans, La.—My experience with this method of therapy is so limited that I should prefer to direct comments not toward the method but toward the general problem which it raises; that is, accurate and critical evaluation of any form of therapy. We all tend to be optimistic about any new method. Perhaps this is basically desirable. I know from my own experience how easy it is to become enthusiastic about any new form of therapy which in the early phases of its application seems to lead to clinical improvement. It is particularly easy to become enthusiastic when you are yourself interested.

I would not wish my remarks to be construed as critical of the evaluation which the essayist has made of the results of this form of therapy. He has properly emphasized the fact that it is not curative, that it has been used only in hopelessly inoperable cases, and that clinical improvement is about all that it seems to provide. It is important to remember, however, that clinical improvement is on the whole a variable and unreliable criterion to employ in the evaluation of any new form of therapy, especially if the agent is administered parenterally. Too many other factors, alone or in combination, may bring about similarly good results. The interest shown by the physician in the patient, the patient's own strong desire to recover, which is particularly evident in incurable disease, and dietary and supportive measures all play a role, and the specific agent employed must be assessed against them by the careful use of controls.

History is full of classic examples of how easy it is to be misled in these circumstances. About ten years ago, for instance, injectable agents became widely popular in the treatment of peptic ulcer. Numerous reports were published indicating good results from them. We also had excellent results from them, but unfortunately we had equally good results in the control series in which the injections consisted only of sterile water.

DR. CHESTER MOEN, Chicago, Ill.—This is a brief résumé of ten patients with proved carcinoma of the lung who have been treated with nitrogen mustard this year at Wesley Memorial Hospital.

It so happens that the first five patients appearing on this slide had squamous cell carcinoma and showed no response while the last five had undifferentiated carcinoma and showed some response.

Among those that showed response to Methyl-bis, there was one case which was particularly dramatic. This patient had a complete atelectasis of the left lung, a fixed vocal cord, a lot of pain and cough, and a septic type of fever. Three days after the administration of this drug, the fever went away and remained normal. Six weeks later the pain had disappeared and the patient had gained ten pounds in weight. However, after two months the pain recurred and in spite of repeated injections of the nitrogen mustard, he has not improved.

Two other patients had large metastatic masses at the base of their neck. Ten days after the administration of this drug, the masses were definitely smaller and softer; the circumference at the base of the neck measured as much as two inches less. This regression continued for about a month. However, after five weeks it was noted that the tumor was progressing. Biopsies were taken before and after the administration of the nitrogen mustard but we were not able to detect any change in the anaplastic picture. In none of these cases was there any change on the chest x-ray.

In view of this early but brief response, one is led to suspect that the benefit derived from nitrogen mustard may, perhaps, be due to its effect upon the surrounding inflammatory tissue rather than upon the tumor tissue itself. We have had no bad effects from giving this drug; however, it is advisable to wait a week or two after thoracotomy before giving it, because of the brief but sometimes severe leucopenia which follows.

DR. FREDERICK R. HARPER, Denver, Colo.—I would merely like to add ten cases to the series.

I visited Dr. Skinner and Dr. Carr in Memphis in December. At that time they suggested this method of treating inoperable carcinomas of the lung. I obtained enough to treat ten patients, and I will just report the results in the ten I treated.

They were all inoperable carcinomas, proved either by biopsies of cervical lymph nodes or thoracotomy. Three of the patients are dead. In one of these, autopsy showed some necrosis of the liver which might have resulted from the toxic effects of the drug.

Seven patients are still alive. Two have obvious metastasis still present. In one of the cases in which there was lymph node involvement from which a biopsy was obtained, after treatment the lymph nodes disappeared, although the tumor in the lung is still present.

There were two cases in which there was a rather unusual phenomenon. These patients coughed up large plugs. Examination of these plugs by a pathologist showed them to consist of necrotic tumor tissue. In one case there was a rather striking clearing of the atelectasis after administration of the drug.

In all of the cases it seemed as though the cough had lessened, the pain was less severe, and the patient was clinically improved.

The main recommendation I could make for the drug is the fact that the patients felt symptomatically and psychologically better in that something was being done for them when they had an inoperable carcinoma.

DR. EDWARD E. AVERY, Hines, Ill.—I would like to report another nine cases, at Hines Hospital. We have had the drug for only three months.

Six of the patients had definite beneficial results in the relief of dyspnea and cough, and gain of weight. Four of the patients were on morphine every three hours. Following treatment, two of the patients needed no medication and the other two took one hypo for sleep at night.

There were two dramatic results. One patient was in complete anuria; he was given a course of Methyl-bis and started to urinate—why, we do not know. Another patient had superior vena cava obstruction with largely dilated neck veins and had extreme pain. Following a course of Methyl-bis, signs of his obstruction disappeared; and he was relieved of pain.

The drug has definite dramatic appeal to the patients, and the psychogenic point should be re-emphasized. Already a whispering campaign is starting, and the patients are asking for this "new, poison gas treatment."

DR. OSLER ABBOTT, Atlanta, Ga.—I would just like to mention five cases in which we have used this drug, because it emphasizes Dr. DeBakey's remarks to such an extreme degree.

We purposely made a point of not giving any additional psychotherapy with the drug. We saw absolutely no beneficial effects from the period of its use. In one patient a severe lymphopenia occurred, and lasted for several weeks. This patient became nauseated under treatment and continued to have this severe complaint until the time of death, approximately ten weeks later.

We have come to the feeling in this very small group that we would rather confine the use of the drug to the Hodgkin's cases until we have a larger supply.

DR. EDWARD F. SKINNER, Memphis, Tenn.—I would like to thank the discussants, especially Dr. DeBakey. His comments are most pertinent.

It is a new drug. We are not trying to detail it here. We just thought our reports were interesting enough to warrant further discussion.

# NONMALIGNANT INTRATHORACIC LESIONS SIMULATING BRONCHIOGENIC CARCINOMA

## Report of 30 Operated Cases

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### INTRODUCTION

THE increasing number of cures that are being effected by total removal of primary bronchiogenic carcinoma places a great obligation upon the physician to establish the diagnosis early enough to permit complete excision of the tumor. In those cases in which the malignancy is visible with the bronchoscope, the diagnosis can be made with certainty by obtaining a biopsy under direct vision. However, when carcinoma of the lung arises in a branch bronchus which cannot be seen at bronchoscopy, the early diagnosis may be extremely difficult. Too often, the physician permits an operable "peripheral" primary bronchiogenic carcinoma to become inoperable by waiting until the diagnosis is definitely established before referring the case to the surgeon. Too often the surgeon hesitates to perform pulmonary resection for fear of doing an "unnecessary" operation. Therefore, this study of peripheral pulmonary lesions simulating bronchiogenic carcinoma has been undertaken in order to evaluate the eventualities should the pulmonary condition be proved nonmalignant at operation. This report represents a review of thirty operated cases in which, although carcinoma of the lung was suspected, various benign lesions were found.

### PRESENTATION OF THE CLINICAL PROBLEM

In primary bronchiogenic carcinoma, the complexity of the clinical problem is directly dependent upon the percentage of cases in which a positive diagnosis cannot be made by bronchoscopy. In spite of the fact that the tumor may be located close to the hilum, we arbitrarily classify all cases as "peripheral" where the lung cancer arises beyond the limits of bronchoscopic diagnosis. Although the reports in the literature state that from 60 to 75 per cent of the cases of bronchiogenic malignancy are visible at bronchoscopy, in our experience less than one-half the cases could be diagnosed by this examination. During the past six years we have seen over 300 patients with primary bronchiogenic carcinoma. Even with the use of the right-angled mirror introduced into the bronchoscope and "blind biopsies," a positive bronchoscopic diagnosis of carcinoma was made in only 45 per cent of the patients. In the remainder, the diagnosis was made by an analysis of all the clinical findings. The seriousness of this problem is brought out by the fact that only one-sixth of all our cases were operable. It is true that in many instances the diagnosis was not made early because the classical signs and symptoms of primary pulmonary malignancy were misinterpreted by the physicians who first saw these patients. How-

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ever, in a large percentage of cases the chest roentgenograms demonstrated the lesion to be peripheral and so, because of lack of a positive diagnosis of cancer, the tumor was allowed to become inoperable. The only hope of cure of these peripheral tumors is complete excision while the neoplasm is still confined to the lung. This can be accomplished by exploration in all patients where a peripheral lung cancer is a strong possibility. We have gradually adopted this plan of attack and are convinced that it offers the only chance for cure in these peripheral malignant tumors. If this surgical philosophy is pursued, the benign lesions will be removed also. The common attitude is to regard the removal of a nonmalignant pulmonary lesion as a "surgical error"; in fact, this was our original belief. However, as we discovered more and more of these benign conditions at surgery, we were impressed with the fact that the great majority of the patients were cured by surgical excision. On the other hand, a few of the patients were not improved. It seemed valuable, therefore, to review our experiences with these nonmalignant conditions, not only to arrive at better standards of differential diagnosis but to evaluate the results of the surgical treatment.

The benign group of cases that simulate peripheral pulmonary malignancy is composed of a wide variety of conditions. The thirty cases reviewed in this study represent the most common examples of the type of case that may be found, but do not include all the eventualities present in the wide field of pulmonary disease, as shown in Table I. This study, therefore, is not intended as

TABLE I. DIAGNOSIS OF THIRTY BENIGN CONDITIONS SIMULATING BRONCHIOGENIC CARCINOMA

| INFLAMMATORY | | BENIGN TUMOR | | DEVELOPMENT | |
|---|---|---|---|---|---|
| Lung abscess | 6 | Adenoma | 3 | Cysts | 3 |
| Tuberculosis | 5 | Lipoma | 2 | Thyroid | 1 |
| Pneumonitis | 3 | bronchial | 1 | | |
| Bronchiectasis | 3 | pleural | 1 | | |
| Granuloma | 1 | Fibroma | 1 | | |
| Echinococcus | 1 | | | | |
| Silicosis | 1 | | | | |
| Totals | 20 | | 6 | | 4 |

a statistical report, because this series is not large enough to include all types. The important clinical findings of the benign group of cases are listed together (Table V) so that they may be more simply compared with similar data in a representative group of malignant cases with negative bronchoscopy (Table VI). After a general consideration of the clinical and roentgenological findings, the individual categories of the nonmalignant cases are discussed separately.

## DIAGNOSIS

Certain clinical and roentgenologic findings are important in arriving at a presumptive diagnosis of peripheral carcinoma of the lung. We have taken a composite of these findings from the reports in the literature and have compared them with similar data obtained from a study of this series of benign cases.

TABLE II. SEX INCIDENCE

| | MALE (%) | FEMALE (%) |
|---|---|---|
| Benign | 53 (16 cases) | 47 (14 cases) |
| Malignant | 85 | 15 |

*Sex Incidence.*—Primary carcinoma of the lung is primarily a disease of the male sex, in which the ratio of males to females afflicted is approximately 5:1. In the cases of the nonmalignant group of this series, the number of females was only slightly less than the number of males; thus, the number of females in the benign group is markedly increased over those in the malignant group.

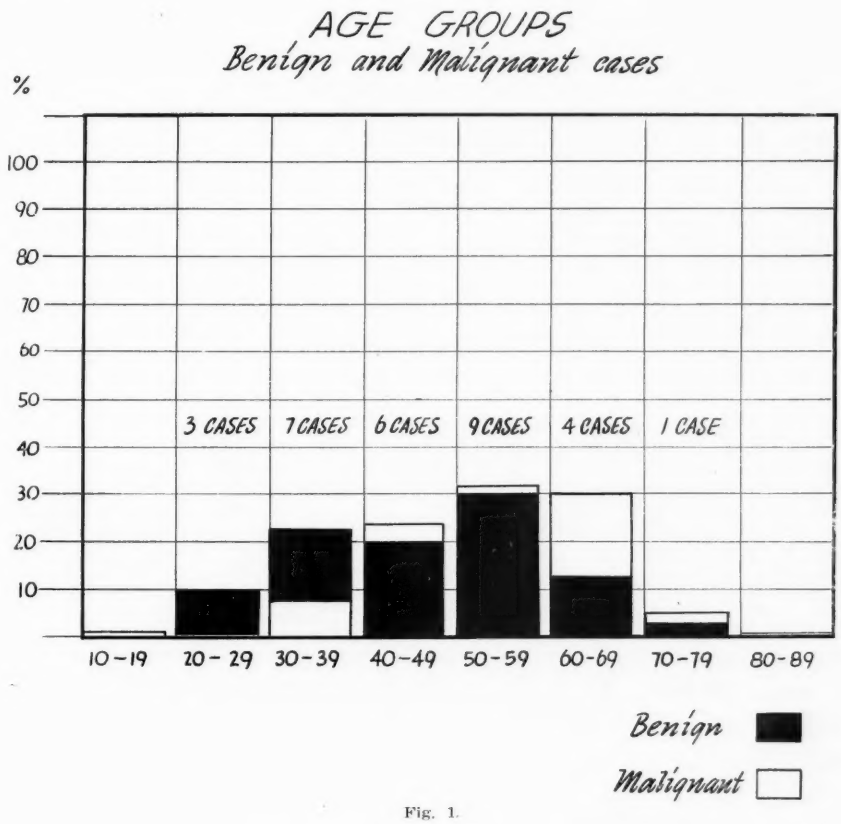



Fig. 1.

*Age Incidence.*—Bronchiogenic carcinoma is found in the second to the ninth decades of life, but 85 per cent of the cases occur between the ages of 40 and 69 years. In the cases of the nonmalignant series, we have a lesser range of ages, the youngest being 29 and the oldest 70 years of age. Two-thirds of the benign cases occurred in the 40 to 69 age group. Of course, a larger series of benign cases might appreciably change this figure and show a greater preponderance of younger persons; however, it is significant in the cases that we have studied that there is a great similarity of the age groups of the malignant and the nonmalignant cases. (Fig. 1.)

*Duration of Symptoms.*—In the group of thirty benign cases, the duration of symptoms varied from two months to almost ten years. The great majority were of less than six months' duration. It is impossible to compare these figures with their wide variation to those of bronchiogenic carcinoma since the duration of symptoms depends on the diagnostic skill of the physician who first sees the case. Most cases of carcinoma are not diagnosed under six months. We have recently successfully performed a pneumonectomy on a 65-year-old male with bronchiogenic carcinoma who had symptoms over a period of eight years and have seen several operable cases with histories of symptoms from one to two years. Although no hard and fast rule can be made, one can assume, if the symptoms persist for more than nine months without the obvious signs of carcinoma, that the lesion is likely to be benign.

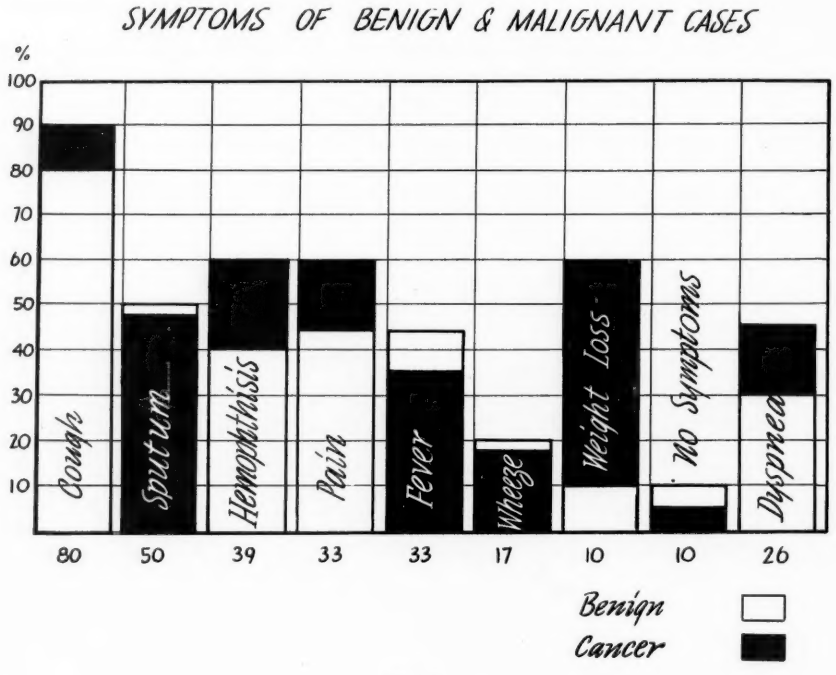



Fig. 2.

*Symptomatology.*—A comparison of the symptoms of the benign and the malignant cases shows a striking likeness (Fig. 2). Although it does not seem profitable to pursue the comparison of small differences in the figures, it is significant that cough, expectoration, and wheezing were found in the same relative percentages in both groups. In evaluating the symptomatology, some emphasis must be placed on weight loss, hemoptysis, pain, and dyspnea, which were more marked in the malignant cases than in the benign group. It is of interest to remember that 5 per cent of the early cases of bronchiogenic carcinoma have been found during the asymptomatic phase during routine x-ray examination.

In our small group of benign cases, 10 per cent were discovered during routine chest x-ray studies. In a recent report of intrathoracic tumors picked up by routine roentgenologic study of navy personnel,[1] five out of twenty-three tumors so found proved to be malignant. This study was made on a relatively young group of persons in which the oldest was 44 years of age and does not represent a large scale study of the same age group, as do the cases in this report. These facts point out, as has been reported previously, that with the increasing use of the periodic x-ray examination, many cases of asymptomatic primary carcinoma will be discovered. The important lesson to be gained from studying the symptomatology of the malignant and the benign groups is not the slight differences of these pooled statistics, but that in general the symptoms are really very similar. Certainly, on symptomatology alone, the differential diagnosis of these two groups of cases cannot be made.

*Physical Examination.*—The physical findings are so varied that it does not seem advisable to catalogue them. The physical examination of the chest shows few physical signs for either the benign or malignant lesion. In both the benign and malignant cases, the findings depend upon (1) the bronchial obstruction and (2) the amount of infection. Therefore, we must not rely on the physical signs to differentiate a localized pulmonary lesion. If, however, the physical signs change from lobe to lobe or spread to the opposite lung, then a migratory inflammatory condition is present rather than a pulmonary cancer.

*Sputum Examination.*—Careful examination of the sputum must be carried out in every case of suspected peripheral carcinoma of the lung. The most important diagnostic procedure is to rule out pulmonary tuberculosis with an "open" type of lesion. If the patient is raising considerable amounts of mucoid or mucopurulent sputum, then a series of negative concentrated sputum examinations for acid-fast bacilli may be taken as a reasonably reliable standard in ruling out "open" pulmonary tuberculosis. However, when the sputum is scanty or nonexistent other methods must be employed. Sputum obtained by gastric lavage or that aspirated from the bronchus draining the pulmonary lesion at bronchoscopy is an accurate source for the detection of the tubercle bacilli. If no sputum is available at bronchoscopy, then a few cubic centimeters of saline may be introduced into the branch bronchus. This bronchus is "lavaged" with the saline solution, which is then aspirated for bacteriologic examination. Such specimens are studied not only for tubercle bacilli but for fungi and the predominating pyogenic organisms.

The sputum aspirated from the draining bronchus at bronchoscopy should also be studied for malignant cells after the staining method described by Papanicolaou.[2] The success of this test is based on the fact that tumor cells are dislodged from the parent tumor and are detectable in the sputum with this stain. Herbut and Clerf[3] have reported considerable success in diagnosing peripheral carcinoma with this method. Although our own experience with this stain is limited, we believe that the early results commend a wider use of this technic. The procedure is somewhat time consuming and the pathologist needs considerable experience to become proficient in the interpretation of the smears.

It should be emphasized strongly that although the finding of malignant cells in the sputum proves the diagnosis of carcinoma, a negative test does not rule out this possibility.

### ROENTGENOLOGIC DIAGNOSIS

When the sputum examination has failed to reveal either a specific infection or malignant cells, then the diagnosis in cases of early peripheral pulmonary malignancy rests mainly on the correct interpretation of the chest roentgenograms. The x-ray findings (Table III) may be classified into five types: (1) masses in the parenchyma of the lung, free from the hilum or parenchymal masses; (2) atelectasis; (3) central masses; (4) abscess cavities; and (5) cystlike structures. Roentgenologic studies of the primary pulmonary malignancies show a relative preponderance of hilar masses as contrasted with the distal ones. With hilar masses, the bronchoscopy is more likely to show the suspected tumor. Atelectasis, too, is a common finding. Cystlike structures and abscess cavities are less frequently observed in malignant pulmonary lesions. In the thirty benign cases in this series, there were fifteen parenchymal masses, seven atelectases, five central masses, two abscesses, and one cystlike formation.

TABLE III. SUMMARY OF X-RAY FINDINGS

| PARENCHYMAL MASSES | | ATELECTASIS | | CENTRAL MASSES | | ABSCESS CAVITIES | CYSTS |
|---|---|---|---|---|---|---|---|
| Abscess | 5 | Benign tumors | 1 | Cysts | 2 | | |
| Benign tumor | 4 | Bronchiectasis | 2 | Pneumonitis | 1 | | |
| Tuberculosis | 4 | Tuberculosis | 1 | Bronchiectasis | 1 | 2 | 1 |
| Pneumonitis | 1 | Granuloma | 1 | Silicosis | 1 | | |
| Thyroid | 1 | Pneumonitis | 1 | | | | |
| | | Echinococcus | 1 | | | | |
| Total | 15 | | 7 | | 5 | 2 | 1 |

We have relied mainly on posteroanterior upright, lateral, and oblique films, supplemented with a careful fluoroscopy in each case to note shift of the lesion and diaphragmatic movement. Potter-Buckey grid films are important to show possible bone destruction. Planograms or tomograms have not proved as helpful as we hoped when this method was first introduced. They distinguish between a solid mass and one with central cavity formation and they show the exact location of the lesion, demonstrating whether or not the mass is fixed to the rib cage, the sternum, etc.; however, the great weakness of these special films is that they do not show the nature of the mass.

Similarly, Lipiodol studies of the bronchial tree may show the presence of a bronchial block, but they do not tell the nature of the block and so give only a presumptive diagnosis. In case of atelectasis when the bronchoscopy is negative, the presence of bronchiectasis may be proved by the simple introduction of the radio-opaque oil. We employ bronchograms mainly to demonstrate the presence of bronchiectasis. It must be remembered that a bronchogram that does not demonstrate a bronchial block has not at all ruled out the presence of a bronchiogenic carcinoma. A diagnostic pneumothorax is helpful only in eliminating the possibility of lesions of the chest wall, mediastinum, and diaphragm, provided that a layer of air can be demonstrated between these structures and the lung.

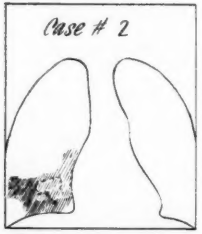
We have used it only occasionally because, in most instances, we have felt that it was important to remove the tumor regardless of its exact site of origin and because pneumothorax is not necessary as a preliminary preoperative procedure.

*Parenchymal Masses.*—Shadows seen in the parenchyma of the lung, free from the lung root, make up the largest group of roentgenologic findings in the nonmalignant group. Diagrams of the x-ray findings are seen in Fig. 3, and although it is impossible to discuss all of these types in detail, certain examples will be presented. The differentiation between the x-ray findings in simple lung abscess and carcinoma is difficult. The onset of a pulmonary abscess is more abrupt, the symptoms more severe, and the roentgen shadow increases more rapidly. When the subacute stage is reached, after a few weeks, there is little change in the size of the x-ray shadow. In the early stage of development of a lung abscess, the zone of infiltration about the abscess is usually greater in the inflammatory cases than in the malignant ones, although exceptions to this rule may be seen (Fig. 7, Case M). As the abscess becomes chronic and fibrosis takes place, frequently only a solid mass is found on the x-ray, as shown in Case 4. This 61-year-old patient gave a history of three months' cough and expectoration with a low-grade fever. X-rays (Fig. 3) showed an enlarging, fairly homogenous mass with a fairly smooth border, in the left lower lobe. In contrast, Case B represents a 42-year-old man with a four-month history of cough and expectoration following tonsillectomy. On the chest x-ray of this patient (Fig. 7), an irregular shadow of the right middle lung field showed rarefaction suggestive of abscess cavities. In spite of the history of possible aspiration following tonsillectomy, a thoracotomy was performed and a bronchiogenic carcinoma removed.

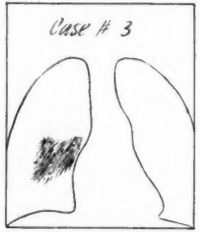
Benign lung tumors generally present slower growing parenchymal masses with relatively smooth rounded contours, as compared with the malignant pulmonary neoplasms. In Case 22, a 50-year-old woman complained of cough and pain in the chest of twelve months' duration. The x-ray showed a lobulated shadow in the lower right lung field. An adenoma of the lung was proved at operation. Similar findings were noted in Case C. Here a 29-year-old man complained of cough for three years and repeated hemoptysis for two years. The roentgen finding was a circumscribed homogenous mass of the lower right lung field. With the three-year history and the youth of the patient, a benign tumor was anticipated; however, an adenocarcinoma was removed at operation. These cases are typical of the difficulty experienced in distinguishing between peripheral benign and malignant tumors from the roentgenologic picture.

Early pulmonary tuberculosis may show an enlarging shadow which, before cavitation occurs and tubercle bacilli are liberated into the bronchial tree, is indistinguishable from a peripheral cancer. In Case 8, an irregular shadow was present in the right upper lobe, in the pulmonary parenchyma, close to the mediastinum. Repeated cultures of sputum, including a specimen aspirated at bronchoscopy, were negative for tubercle bacilli. This patient, a 45-year-old woman, presented a history of cough, low-grade fever, and scanty sputum. She was not appreciably sick and refused to have this mass removed surgically. Some months later, when the lesion drained into the bronchus, she had high fever with

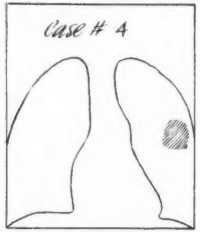
# DIAGRAMS OF XRAYS OF CASES WITH PARENCHYMAL MASSES



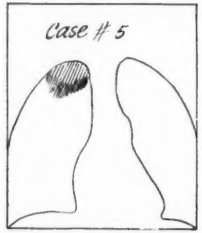
Pulmonary abscess



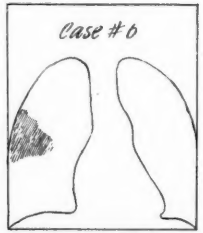
Pulmonary abscess



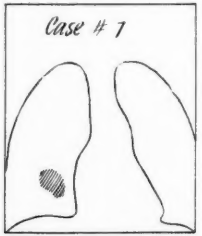
Pulmonary abscess



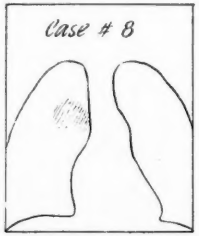
Pulmonary abscess and Fibrosis



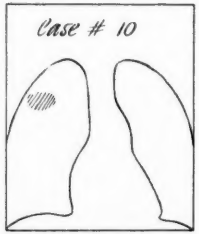
Pulmonary abscess



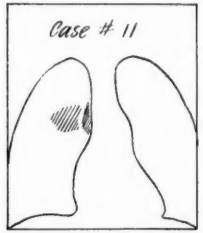
Tuberculoma attached to chest wall



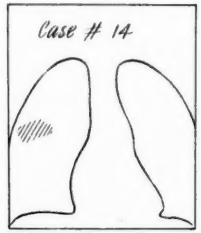
Blocked tuberculosis cavity



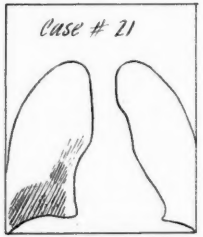
Tuberculoma of lung



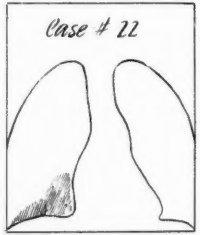
Tuberculoma of lung



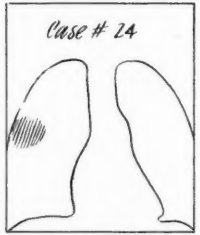
Chronic ilestitial Pneumonitis



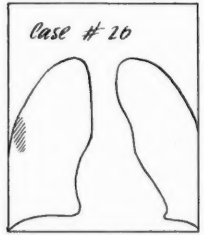
Bronchial Adenoma



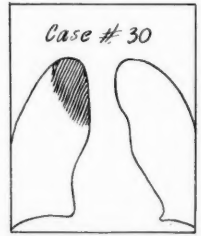
Bronchial Adenoma



Fibroma of Lung



Lipoma of Pleura



Aberrant Thyroid arising from Superior Mediastinum

Fig. 3.

profuse expectoration. At this time the sputum became positive for acid-fast bacilli and cavitation was seen on the x-ray. In Case D, a 53-year-old woman, there was six months' cough with ten pounds weight loss and negative sputum tests for acid-fast bacilli. A slightly irregular shadow was seen in the upper portion of the right upper lobe. This mass gradually increased in size over a period of several months. This patient consented to operation and a bronchiogenic carcinoma was removed.

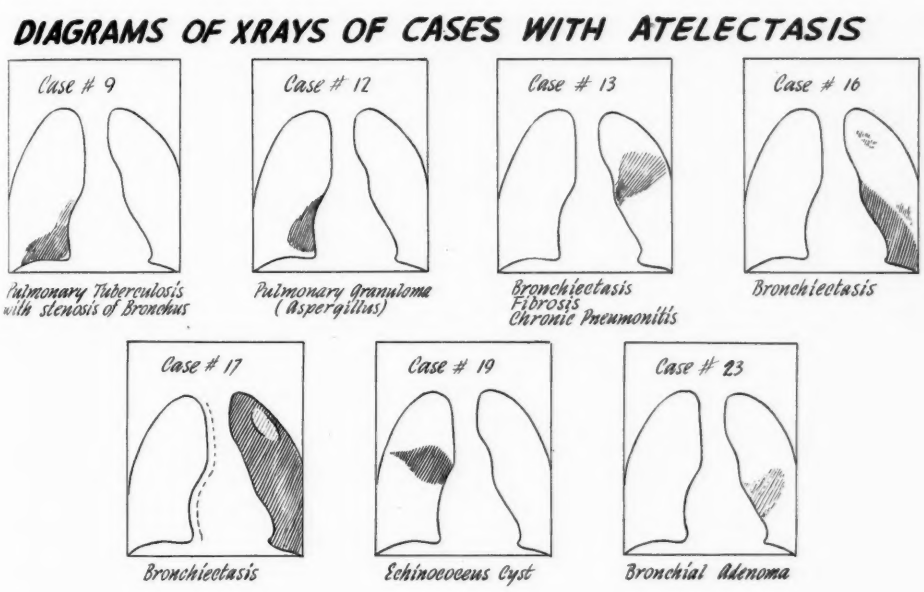



Fig. 4.

*Atelectasis.*—Atelectasis is an x-ray finding that is commonly associated with bronchial obstruction, resultant from an endobronchial tumor, inflammatory lesion, or foreign body. When this obstruction is present in the main-stem bronchi or the orifices of branch bronchi, the diagnosis is readily established by bronchoscopy. In upper lobe obstructions and occasional middle lobe obstructions it may not be possible to see the obstructing mass. Only rarely will a lower lobe obstructing mass be invisible to the bronchoscopist. A diagram of the x-ray findings is seen in Fig. 4. In the benign tumors atelectasis, if present, is usually lobar and a positive diagnosis can readily be made with the bronchoscope. If lobular atelectasis is present, as in Case 23, then the diagnosis rests on operative findings. In this case, a 24-year-old woman complained of recurrent hemoptysis and pneumonia over a period of three years. X-ray showed a shadow in the region of the lingula of the left upper lobe. Following a negative bronchoscopy, a bronchogram demonstrated an obstruction of the lingular bronchus. An adenoma was removed at operation. Case E (Fig. 7) was a 40-year-old man

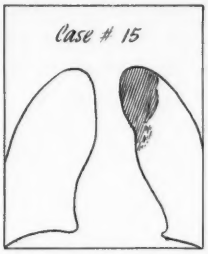
with a history of weakness, cough, and hemoptysis of nine months' duration. X-ray showed an irregular shadow in the left middle chest which, on lateral view, was seen to be a lobular atelectasis of the superior posterior branch bronchus of the left lower lobe. Following a course of antibacterial therapy, the shadow became markedly smaller; however, most of the symptomatology persisted and at surgical exploration a carcinoma of the lung was removed. Here are two cases of lobular atelectasis, one due to a benign tumor and one a malignant one. Only the longer history pointed to the benignity of the case of adenoma. However, we have seen a fair number of cases of bronchiogenic carcinoma where the history extended over a period of years, in one case as long as eight years.

Atelectasis due to inflammatory conditions presents a variety of findings (as with the benign tumors) and is most common in the upper and middle lobes. Case 19 illustrates a difficult diagnostic problem. This 52-year-old man had symptoms of cough for one year, hemoptysis, and pain in the right chest. The chest x-ray revealed a roughly triangular shadow that was interpreted as atelectasis of a lobule of the right upper lobe. The bronchoscopy was repeatedly negative. At surgical exploration an unusual shaped echinococcus cyst was removed. Since this diagnosis was not suspected preoperatively, no skin test for echinococcus had been done. Another film showing atelectasis of a lobule of the left upper lobe was present in Case 13, where the history was that of fever, cough, and expectoration of 3½ months' duration in a 53-year-old man. At operation, interstitial pneumonitis was found. These cases are contrasted with Case G. In this case a 55-year-old man complained of cough, fever, and expectoration of six months' duration. As was true in all these cases, the bronchoscopy in this case failed to show a bronchial block. A primary bronchiogenic squamous cell carcinoma was removed at surgery.

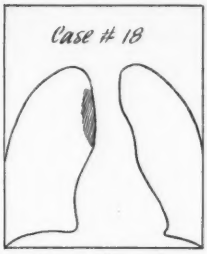
*Central Masses.*—The finding of a central mass in the chest x-ray in a patient with symptoms compatible with bronchiogenic carcinoma makes this diagnosis a likely possibility. In these cases the diagnosis of malignancy is confirmed most often at bronchoscopy. A diagram of the x-rays in the benign group is seen in Fig. 5. One of the benign patients, with a hilar mass on the x-ray and giving a history of cough and palpitation of ten months' duration, had a cyst of the pleura. In the hilar inflammatory lesions the x-ray findings were indistinguishable from carcinoma. Thus, Case 18, who proved to have bronchiectasis of an azygos lobe, presented an x-ray shadow similar to a proved case of carcinoma of the lung (Case H). In a like manner (Case 15) pulmonary adenomatosis may show a perihilar shadow which greatly resembles an adenocarcinoma (Case J).

*Pulmonary Abscess.*—We have previously discussed the lung abscesses that show a more or less solid mass on x-ray examination. The pulmonary abscess which persists and presents the roentgen finding of irregular areas of pulmonary infiltration and rarefaction also offers a difficult diagnostic problem (Fig. 6). There were only two patients in this series with these findings. The first, Case 1, a 70-year-old man, gave a history of five months' cough, sputum, and hemoptysis. The x-ray findings (Fig. 6) were very similar to Case K, in which adenocarcinoma was proved at operation. In the second, Case 25, this 49-year-old man

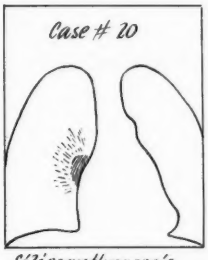
## DIAGRAMS OF XRAYS OF CASES WITH CENTRAL MASSES



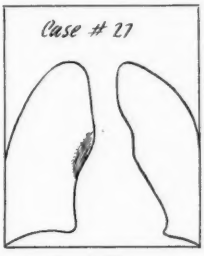

Pulmonary Adenomatosis



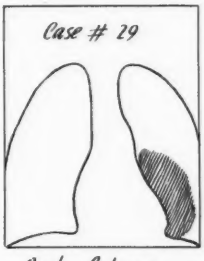

Bronchiectasis




Silicoanthracosis with enlarged hilar lymph nodes



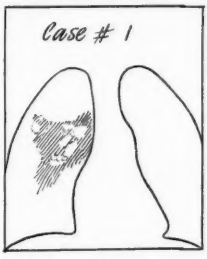

Cyst of Pleura



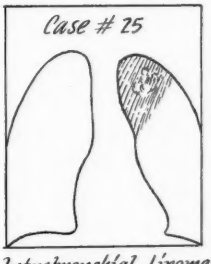

Cyst of Lung

Fig. 5.

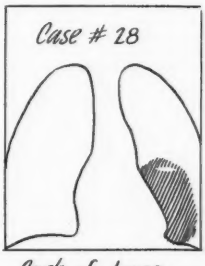
## DIAGRAMS OF XRAYS OF CASES WITH ABSCESSES & CYSTS




Lung Abscess




Intrabronchial Lipoma




Cyst of Lung

Fig. 6.

complained of cough, fever, and chest pain of eighteen months' duration. The x-rays showed a chronic abscess of the left upper lobe with fibrosis and cavitation. Once pulmonary tuberculosis had been ruled out, it was obvious from the bronchogram that an obstruction of the bronchus was present. The most likely cause of the obstruction was a tumor, either benign or malignant. At operation a rare benign lipoma of the bronchus was removed.

*Pulmonary Cyst.*—Although there were three patients with pulmonary cyst in this series, two cysts showed as solid masses on the x-ray examination and only one contained fluid and air with small but definite fluid level. Case 28 (Fig. 6) was a 68-year-old man who complained of five months' cough, sputum, hemoptysis, pain, and dyspnea. The chest roentgenogram demonstrated an ovoid mass almost full of fluid. This case is very similar to Case A (Fig. 7). This 47-year-old man complained of five months' cough, high fever, and foul expectoration which came on following an alcoholic spree where aspiration of vomitus had occurred. The x-ray showed a huge, cystlike structure half full of fluid. An undifferentiated carcinoma was subsequently proved. Certainly symptomatic solitary cysts in persons of cancerous age present almost identical x-ray findings, whether they are benign or malignant, and, therefore, should be removed.

## DIFFERENTIAL DIAGNOSIS

*I. Inflammatory Lesions.—*

*(1) Lung abscess:* The main differential diagnostic problem is whether the pulmonary abscess is secondary to the bronchial obstruction from a malignant neoplasm or to the necrosis of tumor tissue, or whether it developed from some other cause. In the abscess secondary to malignant lesion, there is usually a more insidious onset and the history of wheezing may point to bronchial obstruction. The fever, cough, and constitutional reaction are usually not as high. At bronchoscopy, the amount of hyperemia and swelling of the orifice of the bronchus draining the involved segment of the lung is less in malignant cases than in those of simple lung abscess. On x-ray examination, as has been pointed out, there is less pneumonitis about the pulmonary cavity in the malignant cases than in the benign.

In simple lung abscess, at the stage before a vomica takes place, the fever, toxicity, and prostration are greater than in the malignant, and seem all out of proportion to the amount of pulmonary tissue involved. In the nonmalignant group, the abscesses are more often multiple, there is often a history of antecedent aspiration, a surgical operation, or source for a possible septic embolus. If the abscess disappears with chemotherapy, carcinoma is ruled out, but slight improvement does not eliminate the possibility of a malignant tumor. Actually, no hard and fast rules can be laid down for the differential diagnosis. Out of a series of approximately thirty-five simple lung abscesses, resection was performed in six because the possibility of malignancy could not be completely eliminated. Failure of a lung abscess to respond to conservative treatment may be the only indication that a malignant neoplasm is present. We drained one lung abscess in which not only did the bronchoscopy fail to show the cancer but also biopsies of the abscess wall, taken both at the periphery and at the hilar portions of the

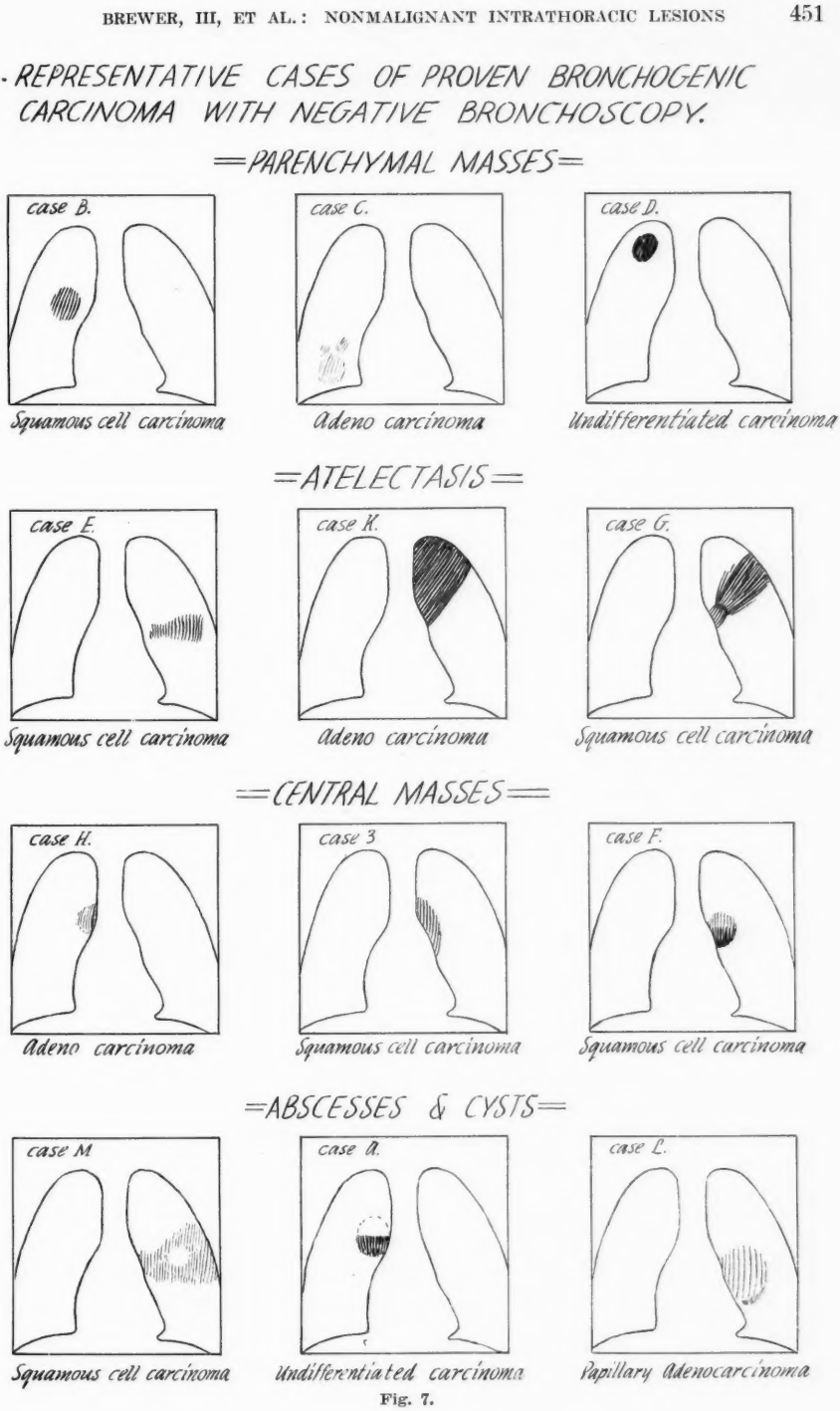

REPRESENTATIVE CASES OF PROVEN BRONCHOGENIC CARCINOMA WITH NEGATIVE BRONCHOSCOPY.
=PARENCHYMAL MASSES=
case B.
Squamous cell carcinoma
case C.
Adeno carcinoma
case D.
Undifferentiated carcinoma
=ATELECTASIS=
case E.
Squamous cell carcinoma
case K.
Adeno carcinoma
case G.
Squamous cell carcinoma
=CENTRAL MASSES=
case H.
Adeno carcinoma
case 3
Squamous cell carcinoma
case F.
Squamous cell carcinoma
=ABSCESSES & CYSTS=
case M
Squamous cell carcinoma
case A.
Undifferentiated carcinoma
case L.
Papillary Adenocarcinoma

**Fig. 7.**

abscess, did not show malignant cells. However, with failure of the abscess to heal, subsequent biopsies revealed the presence of a carcinoma. Had we treated this case with pulmonary resection instead of drainage of the abscess cavity when we first saw the patient, it is quite likely that it would have been possible to have removed the malignant tumor. With the improvement in surgical technique, the results of pulmonary resection for lung abscess have been very much better. A long period of drainage of the abscess is obviated and secondary measures to close the bronchial fistula are not necessary with lobectomy. Because of these facts and because at exploratory thoracotomy a lung cancer can be diagnosed and properly treated, we are coming to the point of view that pulmonary resection instead of surgical drainage is the procedure of choice for a lung abscess that does not promptly respond to conservative measures.

*(2) Tuberculosis:* Early pulmonary tuberculosis in persons of cancer age may occasionally present a clinical picture that is identical with bronchiogenic carcinoma. In the vast majority of instances, the differential diagnosis can be made with careful sputum examinations. The specimen of sputum obtained at bronchoscopy by aspirating the bronchus and draining the pulmonary lesion offers the best chance for detection of the tubercle bacilli. If the patient is expectorating appreciable quantities of sputum, then a negative examination usually rules out tuberculosis. Concentration of three-day pooled specimens of sputum and the more sensitive culture or guinea pig inoculations are the best tests for the detection of acid-fast bacilli. However, in an expanding peripheral pulmonary lesion it is frequently unwise to wait the six weeks for a negative culture for acid-fast bacilli or a guinea pig test when bronchiogenic carcinoma is a strong possibility. Also there is evidence to show that it is wise to resect so-called "tuberculomas" of the lung while the sputum is still negative and the lesion has not broken into the bronchus. In Case 8 of our series, had pulmonary resection been performed when we so advised, it seems likely that spread to the three other lobes of the lung and the necessity for an extensive thoracoplasty would have been prevented. In Case 7, in which the tuberculoma was attached to the chest wall and lung, the possibility of a tuberculous empyema was obviated by resection. In Case 9, in which atelectasis of the right middle lobe and an extensive hemoptysis were the predominating points in the clinical picture, more careful sputum studies would have probably revealed the diagnosis. These last cases are most unusual. The real problem exists in the tuberculoma arising at a distance from the pulmonary hilum, in which the sputum does not contain tubercle bacilli. Here perhaps a very strongly positive tuberculin test may offer presumptive evidence of tuberculosis. We believe that exploratory thoracotomy and resection of such lesions is justified as was done in the two cases in this series. Not only will a possibly early carcinoma of the lung be properly dealt with, but there is a great likelihood that the patient would be saved spread of the tuberculous process to other lobes of the lung should a tuberculoma be removed. Prolonged rest and the general regimen for tuberculous patients must be added to the postoperative care once a diagnosis of tuberculosis has been definitely established by examination of the resected specimen.

*(3) Nonspecific granuloma:* In the single case of nonspecific granuloma of the lung (Case 12), the pathologic findings were that of a chronic infectious

granuloma that did not resemble tuberculosis. The etiology of this lesion has not definitely been determined although Aspergillus was cultured from the sputum; however, the microscopic sections of the specimen were not typical of fungus infection. Because there is no diagnostic test that can be performed before surgery, these cases cannot be distinguished from early pulmonary malignancy. Since the true character of the lesion can be determined only by microscopic section, early removal seems to be indicated. The patient in this series was apparently cured by the resection; there has been no recurrence of the condition.

*(4) Chronic pneumonitis (interstitial):* This classification is somewhat unsatisfactory as it contains a variety of lesions in the alveoli and interstitial tissue producing pathologic changes. The clinical picture is one of localized pulmonary infiltration similar to that of an acute pneumonitis that becomes chronic or gradually spreads in spite of intensive sulfonamide or penicillin therapy. One might suspect that virus pneumonia might come into this category. The x-ray shadows of virus pneumonia, although not typical in themselves, do tend to come and go, and move around. In those cases in which the process lasts for several months, there usually has been enough variation in the x-ray findings to show that the lesion is inflammatory and not neoplastic. The etiology in the three examples of chronic interstitial pneumonitis in this series was different in each case. In Case 14, the pneumonitis was associated with a pneumolith; in Case 15, the infection from sheep gave the picture of pulmonary adenomatosis; and in Case 13, no definite etiology of the interstitial pneumonitis was determined. It should be emphasized that these are not cases of so-called "unresolved pneumonia," a condition that is usually a misnomer and represents some other pathologic condition. In these cases, interstitial or interalveolar inflammations resulting in fibrosis of the lung account for the persistence of the symptomatology and the shadows seen in the x-ray picture. These conditions are rare, and no criterion for diagnosis and treatment has been established. Surgical exploration and resection seem indicated when the persistent x-ray shadow resembles that of bronchiogenic carcinoma.

*(5) Bronchiectasis:* Bronchiectasis is a disease that is chronic in character with well-known signs and symptoms that make the diagnosis usually clear-cut. It occurs most frequently in the first three decades of life and because of its history of chronic pulmonary suppuration, repeated pneumonitis, or hemoptysis, is rarely confused with pulmonary tumor. The x-ray usually shows some peribronchial infiltration and Lipiodol injection establishes the diagnosis of bronchiectasis.

In over 200 patients with bronchiectasis, there were only three in which we suspected a pulmonary malignancy. All three of these showed atelectasis. In two patients there was atelectasis of the left lower lobe, and at bronchoscopy a bleeding obstructing lesion of the lower bronchus was seen. Because atypical cells which resembled malignant cells were seen on the microscopic section of the biopsy specimen, bronchiogenic carcinoma was the tentative preoperative diagnosis. At operation, the lesions were proved to be nonmalignant. In the third case, since the bronchoscopy was negative, an enlarging perimediastinal shadow of the accessory azygos lobe was indistinguishable from a perihilar bronchiogenic carcinoma. Except when an anomalous lobe or possibly an upper

lobe lesion is present, or the biopsy specimen of granulation tissue in the bronchus is equivocal, bronchiectasis will not be confused with bronchogenic carcinoma. In any event, the treatment of bronchiectasis is pulmonary resection provided that the vital capacity or disease in the contralateral lung, etc., does not contraindicate surgery.

*(6) Echinococcus:* Echinococcus disease of the lung usually presents fairly typical clinical pictures. There is often a history of exposure to animals, the x-ray shows one or more cysts in the lung, and similar cysts of the liver are not uncommon. The skin and precipitation tests are highly sensitive and can be relied upon, if strongly positive, to confirm the diagnosis. In the one case in this series (Case 19), the chest x-ray was that of a more or less triangular density close to the hilum. Because this lesion did not resemble a cyst, we did not consider echinococcus as a possibility and so did not perform the diagnostic tests for this disease. A pulmonary malignancy seemed the most likely diagnosis. We have seen other cases in which echinococcus cyst was the suspected diagnosis but in whom the skin test was negative. Exploration revealed pulmonary malignancy. Since the best treatment for echinococcus disease is pulmonary resection, if the condition of the patient permits, pulmonary resection is the procedure of choice.

*(7) Silicosis:* Silicosis is an occupational disease resulting from a long exposure to soluble silicate dust. The history of chronic cough and dyspnea following the inhalation of silica dust usually may be obtained. The chest roentgenogram shows a hilar, sunburst type of infiltration which is usually bilateral. Often there is a fine-grained miliary infiltration in the middle lung fields, leaving the apices and the costophrenic angles clear. Rarely will this clinical and x-ray picture be confused with bronchiogenic carcinoma. In our case there was a history of recent hemoptysis the day before in a man who had previously considered himself well. The x-ray showed a rounded hilar mass on the right and bronchoscopy showed infiltration and distortion of the intermediate bronchus which was interpreted as invasion of the tumor. He had a rather straight left heart border which, in the absence of rheumatic heart disease, we could not explain. An exploratory thoracotomy seemed justified to rule out a bronchiogenic carcinoma. The finding of extensive silicosis of the mediastinal lymph nodes and lung at operation revealed the true source of the hemoptysis.

*II. Benign Tumors.*—Benign pulmonary tumors occur with one-tenth the frequency of bronchiogenic carcinoma. They grow slowly and usually present the symptoms of bronchial obstruction or hemorrhage over a long period of time. Since most of these benign neoplasms arise in the main bronchus or orifices of the branch bronchi to the various lobes, their diagnosis may be made with certainty by bronchoscopy and biopsy in the majority of instances. Some difficulty arises in interpreting the microscopic picture of the varied cell types found in adenomas, but with repeated biopsies the experienced pathologist can usually rule out carcinoma.

Although more common in the younger age groups, these benign tumors are seen in middle-aged persons, also. When the neoplasm arises beyond the range of bronchoscopic vision, the diagnosis is most difficult.

All of the five cases of benign pulmonary tumor in this series arose in bronchi beyond bronchoscopic vision. Three of these cases were adenomas of the bronchus. This represents three out of fourteen cases of adenoma that we have treated in which bronchoscopy failed to show the nature of the tumor. In the other eleven, the diagnosis was proved by bronchoscopy. Two other benign pulmonary tumors in this series were extremely rare: (1) a lipoma of the bronchus arising in the left upper lobe; and (2) a fibroma arising in the right upper lobe. The sixth case proved to be also a rare lesion, a lipoma of the pleura which presented a peripheral shadow simulating bronchiogenic carcinoma. Resection of the peripheral benign tumors was indicated, as cancer could not be ruled out with certainty. Most adenomas of the bronchus come to surgery eventually because of infection in the lung or hemorrhage. These tumors are all potentially malignant so excision is the treatment of choice.

*III. Developmental Conditions.—*

*(1) Pulmonary cysts:* Solitary pulmonary cysts occurring in persons of cancerous age may simulate bronchiogenic carcinoma. If the cysts are multiple, then the diagnosis of carcinoma is remote. The symptoms are varied and depend upon infection in the cyst, the bronchial communication, and the size and position of the lesion. If the pulmonary cyst is asymptomatic and found on routine examination of the chest, then it is unlikely that a malignant neoplasm is present. If, however, the symptoms of cough, and expectoration or hemoptysis are present, then the diagnosis of bronchiogenic carcinoma must be entertained.

In a series of eighteen cases of cystic disease that we have treated, three presented a clinical picture that led us to suspect bronchiogenic carcinoma. In each of these infection was present in the cyst and a communication existed between the cyst cavity and the bronchial tree. In two cases (Case 28 and 29), the cyst mass was in the distal portion of the lung fields and in one case it was contiguous with the hilum. The time element is important, for the longer the history, the less likely it is that a cancer is present. However, we treated one patient (Case M) with a cystlike lesion of the lung which proved to be cancerous, in which the symptoms had been present for 1½ years and a cystlike structure had been observed in chest x-rays over this period of time. Since the ideal treatment of symptomatic solitary pulmonary cyst is resection, then there is no harm in advising early surgery when bronchiogenic carcinoma cannot be ruled out.

*(2) Intrathoracic goiter:* Only rarely will the clinical picture seen with an intrathoracic thyroid resemble that of a primary pulmonary malignancy. Usually there is some associated enlargement of the cervical thyroid, and the intrathoracic goiter is attached to the parent structure. The symptoms of hyperthyroidism may be present. On fluoroscopy, the intrathoracic thyroid, being attached to the ribbon muscles of the neck, may be seen to rise on swallowing. The mass has smoother outlines in the x-ray than does a carcinoma, and symptoms, if present, are usually those of tracheal obstruction. In the malignant tumors of the lung located in the superior sulcus, pain in the shoulder, and Horner's syndrome with recurrent laryngeal nerve paralysis are present when the tumor mass casts a shadow on the x-ray as large as the one in the case we have presented (Case 30). If bronchiogenic carcinoma cannot be ruled out, then

an exploratory thoracotomy by opening the chest widely, not an operation through the suprasternal notch, should be employed, so that the lung may be removed if necessary.

### PROGNOSIS

In twenty-five out of thirty nonmalignant cases in this series, healing of the pathologic condition could not be expected by conservative means alone (Table IV). The lung abscesses which had not responded to antibacterial treatment and bronchoscopic drainage definitely needed surgical treatment. The patients with bronchiectasis, ecchinococcus disease and persistent tuberculomas do not tend to heal spontaneously. In a like manner, benign tumors and the developmental condition could be cured only by resection. It must be admitted, however, that the asymptomatic lesions in the latter category might have existed for a long time before causing trouble. Yet their resection obviated possible difficulties from enlargement, infection, or malignant change. This leaves only the four cases with pulmonary granulomas and chronic pneumonitis in a borderline classification. Although the prognosis for these conditions is not well known without pulmonary resection, a state of chronic disease could be expected. In silicosis, no satisfactory treatment has been devised once the process becomes advanced.

### RESULTS

The results of surgery in these thirty nonmalignant cases are shown in Table IV. The most important fact to be learned from this chart is that in twenty-seven out of thirty cases a cure was effected by the surgical treatment. These patients have remained well for a period of from four months to six years since surgery. In twenty-five instances, or five-sixths of the cases, resection of the lesion was performed. In one of the five remaining cases, pneumonolysis performed at exploration effected adequate drainage of a lung abscess and subsequent healing of the lesion. In the other patient, a thoracoplasty resulted in ultimate curing of the pulmonary tuberculosis. There were two patients unimproved by operation. In one with severe hemoptysis, the resection of the pulmonary tissue failed to arrest the latent tuberculosis in the opposite lung. In

TABLE IV. RESULTS IN THIRTY BENIGN CASES

| DIAGNOSIS | CASES | OPERATION | CURED | UNIMPROVED | DIED | PROGNOSIS WITHOUT SURGERY |
|---|---|---|---|---|---|---|
| *Inflammatory* | | | | | | |
| 1. Lung abscess | 6 | Resection, 5<br>Exploration and lysis, 1 | 6 | 0 | 0 | Poor |
| 2. Tuberculosis | 6 | Resection, 5<br>Thoracoplasty, 1 | 5 | 1 | 0 | Poor |
| 3. Pneumonitis | 3 | Resection, 3 | 2 | 0 | 1 | Fair |
| 4. Bronchiectasis | 3 | Resection, 3 | 3 | 0 | 0 | Poor |
| 5. Granuloma | | Resection | 1 | 0 | 0 | Fair |
| 6. Echinococcus | 1 | Resection | 1 | 0 | 0 | Fair |
| 7. Silicosis | 1 | Exploration | 0 | 1 | 0 | No treatment |
| *Benign Tumors* | | | | | | |
| 1. Adenoma | 3 | Resection | 3 | | | Poor |
| 2. Lipoma | 2 | Resection | 2 | | | Poor |
| 3. Fibroma | 1 | Resection | 1 | | | Poor |
| *Developmental* | | | | | | |
| 1. Cysts | 3 | Resection | 3 | | | Poor |
| 2. Thyroid | 1 | Resection | 1 | | | Fair |
| Totals | 30 | | 27 | 2 | 1 | |

the other unimproved patient, in whom silicotic lymph nodes were found, only an exploratory thoracotomy was performed. The one operative fatality in this group occurred in a man 55 years old with chronic pneumonitis. The cause of death was an extensive spread of infection to the opposite lung, uremia, and sepsis. In reviewing this case, we cannot find any diagnostic signs or symptoms by which bronchiogenic carcinoma could have been ruled out prior to surgery.

## DISCUSSION

In this group of conditions simulating bronchiogenic carcinoma which has been presented, no hard and fast rule can be given to eliminate malignancy. Even after this intensive study, should we encounter similar cases in the future we will operate upon them, for, in the vast majority, carcinoma cannot be excluded.

In these lesions beyond the range of bronchoscopic visibility, the elimination of the possibility of open pulmonary tuberculosis is the most important clinical differentiation. The fact that a shadow on the x-ray film appears to be quiescent in no way excluded bronchiogenic carcinoma. Even if temporary decrease in the size of the x-ray shadow takes place with antibacteric therapy, the lesion may still be malignant; but, if the lesion is migratory from lobe to lobe, an inflammatory lesion can be expected.

Yet, if exploratory thoracotomy is to be performed for these patients, should a pneumonectomy with its higher attendant risks be performed in every instance? The problem confronting the surgeon who has the chest open and the pathologic process under visual and manual examination is often most difficult. Unless the diagnosis of carcinoma is obvious, it is wise to perform a biopsy or wedge resection of the lung which includes the lesion, if possible. Immediate frozen sections and microscopic examinations should be carried out. If a carcinoma is proved, then a pneumonectomy should be performed providing the patient's condition makes this feasible. If the lesion is nonmalignant, then local resection or lobectomy is the procedure of choice. We believe that the evolution of the management of a suspected case of peripheral bronchiogenic carcinoma has reached the same status that is now current usage for carcinoma of the breast. When a lump is felt in the breast, biopsy or local excision is performed. If carcinoma is proved by microscopic examination, a radical mastectomy is performed. Thus, in suspected peripheral bronchiogenic carcinoma, exploratory thoracotomy and biopsy or local excision is performed. Only if cancer is proved is a total pneumonectomy necessary.

## CONCLUSIONS

1. Thirty operated cases of nonmalignant intrathoracic lesions simulating peripheral bronchiogenic carcinoma have been reviewed. This group consisted of twenty inflammatory conditions, six benign tumors, and four developmental abnormalities.

2. The difficulty of the clinical problem in the early diagnosis of bronchiogenic carcinoma is emphasized by the fact that in only approximately one-half of the cases of carcinoma out of a series of 300 that we have treated, could the carcinoma be diagnosed by bronchoscopy. All lesions beyond the limits of bronchioscopic diagnosis are classed as peripheral.

TABLE V. CLINICAL DATA OF THIRTY BENIGN CONDITIONS SIMULATING BRONCHIOGENIC CARCINOMA

| CASE NO. | AGE, SEX | X-RAY | SYMPTOMS | OPERATION | DIAGNOSIS | RESULT |
|---|---|---|---|---|---|---|
| | | | *Inflammation: (1) Abscess* | | | |
| 1. F. N. | 70 M | Lung abscess | 5 months cough, sputum hemoptysis, dyspnea; 15 lb. weight loss | Right pneumonectomy | Bronchiectasis and abscess | Cured |
| 2. K. M. | 65 M | Parenchymal mass | 3 months cough, sputum, hemoptysis, wheeze, dyspnea, pleuritic pain | Exploration and pneumonolysis | Pulmonary abscess | Cured |
| 3. E. K. | 37 M | Parenchymal mass | 3 months cough, sputum, pain | Right lower lobectomy | Pulmonary abscess | Cured |
| 4. R. S. | 61 M | Parenchymal mass | 3 months cough and pain following an operation for herniotomy | Left pneumonectomy | Pulmonary abscess | Cured |
| 5. M. H. | 49 F | Parenchymal mass | 1 month sputum, wheeze, hemoptysis, and high fever | Right upper lobectomy with partial excision of chest wall and ribs | Pulmonary abscess and fibrosis | Cured |
| 6. N. C. | 58 F | Parenchymal mass | 1 month cough, sputum, fever, dyspnea and weakness | Right pneumonectomy | Pulmonary abscess | Cured |
| | | | *(2) Tuberculosis* | | | |
| 7. L. S. | 34 F | Parenchymal mass | 7 months' cough, sputum, low fever, 15 lb. weight loss | Excision of node | Tuberculoma attached to chest wall | Cured |
| 8. S. P. | 45 F | Parenchymal mass | 3 weeks, cough, sputum, fever | (Refused exploration) Right thoracoplasty | Blocked tuberculous cavity | Cured |
| 9. P. B. | 59 M | Atelectasis of right middle lobe | 12 months cough, sputum, hemoptysis, fever and dyspnea | Right pneumonectomy | Pulmonary tuberculosis with stenosis of bronchus | Unimproved |
| 10. L. W. | 37 M | Parenchymal mass | No symptoms | Right partial lobectomy | Tuberculoma of lung | Cured |
| 11. O. C. | 54 F | Parenchymal mass | (Gastrointestinal symptoms for 5 months) | Right lower lobectomy | Tuberculoma of lung | Cured |
| | | | *(3) Granuloma* | | | |
| 12. L. K. | 39 M | Atelectasis of right middle lobe | 12 months cough, sputum, wheeze, and hemoptysis | Right middle lobectomy | Pulmonary granuloma (Aspergillus) | Cured |
| | | | *(4) Pneumonitis* | | | |
| 13. F. N. | 53 M | Abscess and atelectasis | 4 months cough, sputum, pain | Left pneumonectomy | Bronchiectasis and fibrosis, and chronic pneumonitis | Died—(pneumonia) Uremia |
| 14. H. W. | 29 M | Lung abscess | 4 months cough, pain, occasional small hemoptysis | Right middle and lower lobectomy | Chronic interstitial pneumonitis (Pneumolith) | Cured |
| 15. H. B. | 31 F | Parenchymal mass | 8 months sputum, chills, fever, pleurisy: hemoptysis once | Left pneumonectomy | Chronic interstitial pneumonitis with fetalization (Adenomatosis) | Cured |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | *(5) Bronchiectasis* | | | |
| 16. I. D. | 29 | F | Basal atelectasis | 10 years sputum, cough, hemoptysis, dyspnea | Left pneumonectomy | Bronchiectasis | Cured |
| 17. H. H. | 49 | F | Basal atelectasis | 5 months cough, wheeze, dyspnea | Left lower lobectomy | Bronchiectasis | Cured |
| 18. M. T. | 42 | F | Parenchymal mass | 11 years ago bronchial polyp removed; yearly attacks of cough, wheeze, fever | Left upper lobectomy with azygos lobe | Bronchiectasis in azygos lobe of lung | Cured |
| | | | | *(6) Echinococcus* | | | |
| 19. E. S. | 59 | F | Parenchymal mass | 12 months cough, sputum, hemoptysis | Right exploratory thoracotomy with excision of cyst | Echinococcus cyst of lung | Cured |
| | | | | *(7) Silicosis* | | | |
| 20. T. T. | 59 | M | Hilar mass | 1 day hemoptysis, slight dyspnea | Right exploratory thoracotomy | Silicoanthracosis with enlarged hilar lymph nodes | Unimproved |
| | | | | *Benign Tumors: (1) Adenoma* | | | |
| 21. I. W. | 50 | F | Parenchymal mass | 5 months cough, sputum, hemoptysis, weakness | Right lower and middle lobectomy | Bronchial adenoma | Cured |
| 22. F. R. | 50 | F | Parenchymal mass | 12 months cough, pain, soreness | Right lower lobectomy | Bronchial adenoma | Cured |
| 23. E. P. | 33 | F | Atelectasis and pneumonitis | 48 months, recurrent bouts fever, cough, hemoptysis | Right upper lobectomy | Bronchial adenoma | Cured |
| | | | | *(2) Fibroma* | | | |
| 24. M. M. | 30 | F | Parenchymal mass | 24 months pain and cough | Exploratory thoracotomy with excision of tumor | Fibroma of lung | Cured |
| | | | | *(3) Lipomas* | | | |
| | | | | *A. Bronchial* | | | |
| 25. M. B. | 49 | M | Lung abscess | 18 months cough, wheeze, and pain | Left pneumonectomy | Intrabronchial lipoma | Cured |
| | | | | *B. Pleural* | | | |
| 26. M. Mo. | 60 | M | Parenchymal mass | 1½ months cough and sputum | Exploratory thoracotomy with excision of tumor | Lipoma of pleura | Cured |
| | | | | *Developmental: (1) Cysts* | | | |
| 27. R. R. | 55 | M | Hilar mass | 10 months cough and irregular heart action | Exploratory thoracotomy with excision of cyst | Cyst of pleura | Cured |
| 28. M. U. | 68 | M | Parenchymal mass | 5 months cough, sputum, hemoptysis, pain, and dyspnea | Right lower lobectomy | Cyst of lung | Cured |
| 29. S. A. | 40 | F | Parenchymal mass | No symptoms | Exploratory thoracotomy with excision of cyst | Cyst of lung | Cured |
| | | | | *(2) Aberrant Thyroid* | | | |
| 30. R. D. | 29 | M | Parenchymal mass | No symptoms | Exploratory thoracotomy with excision of tumor | Aberrant thyroid arising from the superior mediastinum | Cured |

TABLE VI. REPRESENTATIVE CASES OF PROVED BRONCHIOGENIC CARCINOMA WITH NEGATIVE BRONCHOSCOPY

| CASE | AGE SEX | X-RAY | SYMPTOMS | OPERATION | DIAGNOSIS | RESULT |
|---|---|---|---|---|---|---|
| A. H. S. | 47 M | Large lung abscess with fluid level | 1½ months cough, fever, hemoptysis | External drainage of abscess, with biopsy | Carcinoma, undifferentiated | Living at 6 months |
| B. F. S. | 42 M | Parenchymatous mass near hilum | 4 months cough, hemoptysis, following a tonsilectomy | Right pneumonectomy | Carcinoma, squamous IV | Died of metastases in 6 months |
| C. L. K. | 29 M | Parenchymatous mass in lower lobe | Chronic cough for three years; hemoptysis two years before; hemoptysis recently | Right pneumonectomy | Adenocarcinoma | Living and well at one year |
| D. L. H. | 53 F | Parenchymatous mass in upper lobe | 6 months cough; 10 lb. loss in weight | Right pneumonectomy | Carcinoma undifferentiated | Living and well at one year |
| E. B. B. | 40 M | Small area of atelectasis in dorsal branch of lower lobe | 9 months weakness, cough, hemoptysis | Left pneumonectomy | Carcinoma, squamous 11 | Died of metastases in one year |
| F. A. S. | 65 M | Large parenchymatous mass near left hilum | Dyspnea for 20 years; hemoptysis eight years before; recent small hemoptysis | Left pneumonectomy | Carcinoma, squamous cell | Living and well at 9 months |
| G. F. T. | 61 M | Atelectasis at left apex | 44 lb. weight loss following extraction of teeth; one month of cough | Left pneumonectomy | Carcinoma, squamous cell | Died third postoperative day |
| H. J. A. | 44 F | Parenchymatous mass | 12 months cough and sputum | Right pneumonectomy | Adenocarcinoma | Died of metastases in one year |
| J. H. C. | 63 M | Parenchymatous mass near hilum | 12 months cough, sputum, hemoptysis, and occasional fever | Left pneumonectomy | Carcinoma, squamous cell | Living 2 years later but has metastases |
| K. M. L. | 55 F | Atelectasis in upper lobe | 12 months cough; 20 lb. loss weight; 4 months pain in left chest | Lobectomy, left upper lobe | Papillary adenocarcinoma | Living and well at 1 year |
| L. M. S. | 45 M | Lung abscess | 4 months cough, wheeze, pain, hemoptysis | Exploratory thoracotomy | Squamous cell carcinoma | Living at 6 months |
| M. L. P. | 55 M | Infected lung cyst | 18 months cough and sputum | Lobectomy, left lower lobe | Papillary cyst adenocarcinoma | Living and well at 4 months |

3. After a careful study of the clinical and x-ray findings, we are forced to admit that most often the differentiations between the peripheral malignancies and nonmalignant conditions cannot be made without exploratory thoracotomy.

4. Exploratory thoracotomy and microscopic examination of biopsied specimens represent the only sure methods of distinguishing between the malignant and this group of nonmalignant peripheral lesions.

5. In twenty-three out of thirty cases in this benign group simulating bronchiogenic carcinoma, cure could not be expected by conservative treatment; six cases fell in a borderline group; and one was hopeless regardless of treatment employed.

6. Twenty-seven out of the thirty nonmalignant conditions were cured by surgery, two were unimproved; one postoperative death occurred.

7. This study should give confidence to the surgeon to perform exploratory thoracotomy for the peripheral intrathoracic lesions where bronchiogenic carcinoma cannot be ruled out. If a carcinoma is found, total pulmonary resection offers the only chance for cure. If a nonmalignant condition is discovered, we can conclude from this experience that in most instances the pathologic condition will prove to be one that is cured by simple local resection.

8. We believe that the management of a suspected case of peripheral bronchiogenic carcinoma has reached a status similar to that of suspected carcinoma of the breast with exploration, biopsy, and radical excision, if cancer is proved.

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## DISCUSSION

DR. EVARTS A. GRAHAM, St. Louis, Mo.—I want to commend Dr. Brewer for bringing this to our attention so forcibly.

I agree wholeheartedly that exploratory thoracotomy should be undertaken much more often than it is. The reason that it is not undertaken more often is simply because of the conservatism of members of the medical group, who generally have these patients in their control over a long period of time.

Dr. Brewer did not say anything in particular about tuberculoma, but it seems to me that with the present safe state of thoracic surgery one will not go far wrong in advocating the removal of large tuberculomas. We have been carrying out this policy for some time with no regrets.

On the other hand, I am sure we are familiar with patients who have carried tuberculomas for an indefinite period of time, and were told there was nothing to worry about, only to have the thing suddenly become active, with the dissemination of tuberculosis, often in a bilateral form, with the serious consequences of that complication.

DR. DAVID H. WATERMAN, Knoxville, Tenn.—I agree entirely with Dr. Brewer that tuberculosis should, of course, be ruled out in these patients. I would like to bring to your attention, however, eight cases we have had in which a positive sputum was obtained which in each case proved to be a red herring.

In all of the eight cases a diagnosis of bronchiogenic carcinoma proved to be the main pathology, but in three of them the presence of positive sputum delayed our surgery sufficiently long that a poor result was obtained where a good result might have been achieved by earlier operation.

The explanation for the positive sputum may be that the bronchiogenic carcinoma has eroded into an old tuberculous focus. I have heard other chest surgeons make the same observation. To reiterate, I think we cannot place too much importance on a positive sputum, particularly if it is an isolated specimen.

DR. F. R. MAUTZ, Cleveland, Ohio.—I just wish to show one case that has been quite interesting and instructive to me.

(Slide.) This was a man 36 years old, who, a year or so previously, had a rather severe injury to the left chest and some months later began to have pains in the left chest. A month before this picture was taken, he consulted his physician, and this circumscribed lesion was found in the periphery of the left lung field.

Bronchoscopy did not help us make a diagnosis. He had no fever or signs of a pyogenic inflammatory lesion, so we proceeded with an exploratory thoracotomy, on the assumption that we were dealing with a primary lung tumor.

At operation we did find a lesion in the periphery that came up near the surface of the pleura. Apparently it went across the interlobar fissure, and we were still a bit at a loss to know what it was. It was rather hard in consistency. We thought that perhaps we could get some help from a frozen section and we took a small piece from the pleura and had a frozen section done in the operating room which gave us the impression that we were dealing with an adenocarcinoma, so we proceeded with a pneumonectomy.

(Slide.) This was the lesion as it appeared in the lung; when the pathologist examined the paraffine sections of the lesion, he called me up and asked me if I would check to see what the man's Wassermann reaction was. I went to the chart, and to my chagrin, found that a routine admission Wassermann had not been done. There was one listed as having been drawn the day of operation, and needless to say, it was 4 plus.

This patient has been followed for three years and he has remained well. A course of antisyphilitic therapy has been recommended but the patient has not been very faithful about taking the treatments. No doubt the penicillin that he had following operation was helpful in this regard.

Does the essayist have any comments to make on the treatment of these large gummas of the lung? If we had known that this was a gumma, we would have instituted some antisyphilitic therapy prior to thoracotomy.

DR. EDGAR W. DAVIS, Washington, D. C.—I believe for scientific reasons—and to emphasize what Dr. Graham has said—that if one's clinical diagnosis could be substantiated preoperatively it possibly would influence the clinicians to refer these undiagnosed lesions to the surgeons. However, for practical purposes I do not feel that it is necessary to ascertain the clinical significance preoperatively of these lesions. In my opinion all of them should be explored.

In 1945 we* reported fifty-eight cases that had had all conceivable studies in our armamentarium. We were unable to arrive at any definite diagnosis in any case. We operated on these patients and in the over-all age group we found 73 per cent to be malignant.

We have just been reviewing a series of intrapulmonary tumors. We have forty in this series. One patient refused surgery and thirty-nine were operated upon. This group ranges anywhere from 29 to 69 years of age, with an average age of about 52 years. Of this group of forty cases, we have a total of 70 per cent malignancies. Of the forty patients, there were twelve who had no symptoms at all. These twelve were picked up largely during the war, when inductees or volunteers for service in the armed forces were routinely screened. They had no symptoms at all, and were surprised to be told that they had anything in their chest which would disqualify them for service in the armed forces. Of these patients without symptoms, 66 per cent, or 8, had malignant tumors.

I am sure all of us were very interested in these x-rays presented by Dr. Brewer. He called some of them carcinoma that I did not think were carcinoma. This last case presented looked to me as if it were a very clean-cut film of a cyst in the lung. This shows the necessity for operating upon what roentgenographically appears to be an innocuous lung cyst. Dr. Graham has called our attention a number of times in recent years to the fact that many of these cysts have malignancies within them.

*Drs. Edgar W. Davis and Roy G. Klepser, Washington, D. C.

I sincerely believe that so far as the practical application of therapy in these undiagnosed, intrapulmonary, or intrathoracic neoplasms is concerned, that it is just as imperative to operate and find out their true significance as it is to remove an undiagnosed nodule from the breast.

DR. RICHARD H. SWEET, Boston, Mass.—I have long been an advocate of this procedure in these doubtful cases where diagnosis is so difficult, but I would also like to point out to you that, at least in my experience, it is not such an easy matter with the lung under our fingers and with our eyes upon it, to be absolutely sure of what we are dealing with.

I have made errors in both directions—calling benign lesions malignant ones, and malignant ones benign. On the other hand, I think we can make wide use of this method, many times performing a biopsy, actually taking pieces of lung tissue, lymph nodes, and so forth, in order to find out exactly what we are dealing with, but even then we have to wait sometimes for several weeks for the pathologist to make up his mind as to what it was that we took out for him.

There is one interesting group of cases which I have encountered that I think Dr. Brewer mentioned on his list of diagnoses, which we have called chronic pneumonitis, and which appars to be a clinical and pathologic entity, and which, in our hands, is very difficult to differentiate from carcinoma, even at the operating table. Perhaps you would like to comment on your experience with that, Dr. Brewer.

DR. A. LINCOLN BROWN, San Francisco, Calif.—There is one form of chronic pneumonitis which I am sure the essayist would not object to having added to the list; that is lipoid pneumonia, of which one does not see too much. I have just had the experience again, in a fifth case. It is always very satisfactory to run across, and gives you a much better prognosis as far as the patient is concerned, but, being a progressive disease, warrants at least a local excision and possibly a lobectomy.

DR. L. A. BREWER, Los Angeles, Calif.—In response to the question regarding the gumma, I believe there are only a very few published case histories, so that this case, by all means, should be reported. We have not run across one in our series.

The problem that confronts the surgeon when he has the thorax open and can palpate the mass in the lung is often extremely difficult. Wherever possible, we take a biopsy of the lesion and the adjacent lymph nodes. Carcinoma can usually be ruled out in all cases except tumors covered by the great vessels close to the hilum.

As time goes on there will be more and more explorations, more local resections, and fewer pneumonectomies for all except the hilar masses. Actually, we did nine pneumonectomies, eleven lobectomies and eight local excisions in this series. As our experience widens, we will be able to tell more accurately which cases will need a total pneumonectomy.

I am sorry that this vast subject had to be covered in such a short period of time. There were many questions of interest that we would have liked to discuss further, such as tuberculosis, mentioned by Dr. Graham, interstitial pneumonitis, suggested by Dr. Sweet, and others. The written account of this paper presents more detail on these subjects.

We have presented this series of cases in the hope of stimulating surgeons in the Society to present their experiences with nonmalignant lesions simulating bronchiogenic carcinoma, for it is only by the collective experience of a large number of cases that the best standards of therapy can be evolved.

# AN IMPROVED METHOD OF RESECTION OF PULMONARY SEGMENTS

## Report of a Technique Applied in Seventy Operations

Richard H. Overholt, M.D. (by invitation), Francis M. Woods, M.D., and Reeve H. Betts, M.D.
Boston, Mass.

PULMONARY diseases amenable to surgical excision often involve one or more segments of lobes. At times the affected segments are contiguous, but often they are distributed in different lobes either on one or both sides of the thoracic cavity. In such cases it is desirable to save the normal segments as functioning units. Where multiple areas are concerned, it may become imperative to conserve all healthy segments in order to preserve sufficient pulmonary function to sustain active life and yet eradicate the disease.

Thoracic surgeons have long recognized the surgical significance of the pulmonary segment. Nelson[6] discussed the segments from the standpoint of proper posturing of patients when bronchial drainage was necessary. He also pointed out that the superior segments of the lower lobes were entitled to be given separate consideration for they acted independently from an anatomic and clinical point of view. Churchill and Belsey[3] were early to point out the frequency of involvement of the lingula of the left upper lobe in bronchiectasis and the importance of its resection. They described a method of removing the lingula by preliminary occlusion of the segmental bronchus, reinflation of the lobe, and the division of lung tissue between clamps, and stated that "clamps are placed just on the atelectatic side to allow greater freedom in suturing. Running stitch ligatures are then placed on the lung substance held by the clamps." Churchill and Belsey also employed this method in two cases of bronchiectasis in which the basal group of segments were removed, thereby preserving the superior segment. Adams[1] has called attention to the practical importance of "segmental pneumonectomy" and has illustrated a method for removal of basal segments applying two clamps to the lobe. He places the blades of the clamps so that they grasp the lung from opposite directions and their points closely approximate one another so that all of the tissue between the superior segment and the basal group is included. Suturing of the lung surface is also recommended. Blades[2] has discussed the importance of the conservation of uninvolved segments, particularly in treating bilateral bronchiectasis. For the lingula, Blades has found the method of Churchill and Belsey entirely satisfactory. For removal of the superior segment of the lower lobe, the bronchus is occluded and clamps are applied to the line of demarcation. Blades states, however, that "partial excision of the basal division of a lower

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lobe necessitates incisions through rather thick vascular lung tissue. Extirpation of the diseased lobules in this location may be accomplished by placing one small hemostat at the desired position and incising the tissue below the level of the instrument. . . . After the division of approximately one inch of lung tissue the line of incision is approximated and the positions of the vessels held by the proximal clamp are determined. The vessels are controlled by suture ligatures before the clamp is removed. By repeating this maneuver, the segment or desired amount of lung tissue is excised. . . . The raw cut surface of the lung parenchyma is then covered with a large graft of parietal pleura which is obtained from the chest wall." Blades has employed this method in seven cases, not including lingulectomy.

For many years we used the methods described by Churchill and Belsey,[3] Adams,[1] and by Blades[2] for the excision of the lingula. This segment is the most accessible of all for it is the counterpart of a lobe (the right middle) and frequently is partially separated by an accessory fissure. It has but one intersegmental plane which is often a narrow one. The clamp and suture methods have not proved to be satisfactory in the excision of other segments. Lung clamps and hemostats cannot be placed precisely on the intersegmental plane. At some area in the intersegmental plane either too much or too little tissue will be included in the clamps. If the former, infected tissue may remain behind; if the latter, healthy tissue is traumatized. The use of clamps makes suturing obligatory. The raw surface of the adjacent and healthy segment cannot be sutured without distortion of its shape or reduction of its volume. Furthermore, it is difficult to place the sutures when the segment is fully expanded. We have found it necessary to place the sutures when the lobe is partially or totally collapsed. We also have found that with expansion of the segment there is frequently disruption of the sutures. It was because of the technical difficulties that we encountered with the clamp and suture method in the removal of other pulmonary segments than the lingula, that we felt that a different way to take the lobe apart should be developed. Three years ago we developed a method of removing any of the eighteen segments without the use of lung clamps and without the use of sutures on the denuded surface. This can be accomplished without appreciable damage to the neighboring segments. In a previous report,[7] we described experiences with this procedure in twenty-three operations on twenty-one patients. That experience has now been extended to fifty-nine segmental operations on fifty patients with bronchiectasis, and to an additional eleven segmental operations for other conditions. After we had submitted our first report for publication, Clagett and Deterling[4] described a method of removing the lingula by dissecting the segment in a retrograde manner. They do not use clamps but suture the denuded surface of the lung. They suggested that their method might be applicable to other segments.

## TECHNIQUE

Each bronchopulmonary segment has its own bronchus, arterial blood supply, and venous return. The bronchus and artery penetrate through the hilum of the segment into its substance where their subdivisions arborize. The venous

channels in turn collect into tributaries which tend to run along the surface of the segment through the hilum back to the pulmonary veins. There are no arterial or bronchial communications from one segment to another. Occasional venous communications are encountered but the main venous return from a segment is by way of its own hilum. Rarely, partial pleural fissures occur between segments, giving additional evidence that they are true bronchopulmonary units. At all times loose areolar tissue is all that binds a segment to contiguous segments once the artery, vein, and bronchus at its hilum, and the pleura at its periphery are divided. Since this loose areolar tissue can be separated with relative ease, it is possible with certain precautions to apply to segments of pulmonary lobes the principles of individual ligation technique now universally accepted in resection of entire lobes.

The patient is prepared for operation by paravertebral injection of 0.4 per cent procaine hydrochloride into the second to eighth intercostal nerves. The parascapular region is also infiltrated. An endotracheal tube is inserted under topical cocaine anesthesia, and the saphenous vein is cannulated for infusion of fluid and blood. The operation is done with the patient in the face-down position, the diseased side slightly lowered to minimize the flow of secretions into the tracheobronchial tree. The chest is opened through a posterolateral parascapular incision, the pleura being entered through the intercostal space or rib bed most convenient to the diseased area. Adhesions are divided and the lung palpated and inspected.

The general plan of resection is the same for all segments. Exact knowledge, not only of the distribution of the arteries, veins, and bronchi to the lobes, but also of the points of origin and relations of the arteries, veins, and bronchi to the various segments, is, of course, fundamental. There are four main structures to be isolated and divided in separating off each segment: the artery, the vein, the bronchus, and the pleura.

In most instances the segmental artery is first dissected out and divided between silk ligatures. On the right, after the upper lobe has been retracted caudally and the pleura over the hilum incised, the branch to the apical segment* of the upper lobe is easily identified as the first branch of the pulmonary artery. The branch to the anterior segment of the upper lobe lies just distal to it. On the left the trunk to the apical posterior segment is found in a corresponding position. All the other segmental arteries lie in the depth of the major fissure. To approach any one of them the lower lobe is retracted posteriorly, the fissure is dissected apart, and the pleura is opened at its base. The artery terminates by dividing into three divisions, ramifying on the left into the three segments of the basal division of the lower lobe—the anteromedial, the lateral, and the posterior. On the right there are four such divisions: the anterior, medial, posterior, and lateral. Just above the basal divisions, on the left, the two branches to the lingula are found leaving the anterior surface of the pulmonary artery. In the corresponding position on the right are two branches to the middle lobe. From the posterior surface of the pulmonary artery the branch to the superior segment of the lower lobe arises just opposite or a few millimeters

*We have adopted the nomenclature of Jackson and Huber.[5]

above the origin of the lingular or middle lobe vessels. The artery to the anterior division of the left upper lobe arises just proximal to the lingular branches. On the right the branch to the posterior division of the upper lobe is situated on the lateral surface of the pulmonary artery, slightly proximal to the origin of the middle lobe and superior segmental arteries.

The segmental vein is usually divided after the corresponding artery. These vessels are not, as a rule, difficult to identify. After the lower lobe has been allowed to fall anteriorly, and the inferior pulmonary ligament divided, the inferior pulmonary vein is identified. The dissection is carried distally along the vein to find its first bifurcation. Two tributaries of the upper division drain the superior segment of the lower lobe, while the tributaries of the lower division come from the segments of the basal divisions. The superior pulmonary vein is found anterior to the pulmonary hilum by retraction of the lung posteriorly. The upper branch receives tributaries from each segment of the upper lobe separately only a few millimeters beyond the primary bifurcation. The lower branch of the superior pulmonary vein receives two tributaries from the two segments of the middle lobe on the right or the lingula on the left. Dissection usually need only be carried a short distance out any one of these branches to identify with certainty the segment that it drains.

The segmental bronchus is now identified. At times it is more easily dissected out after the artery. Again it may be ligated early and divided later. Inflammatory tissue or lymph glands often dictate the order in which the structures are taken. The segmental bronchus lies close to and just underneath the corresponding artery. However, ordinarily it is advisable to divide the vein before the bronchus as the thin-walled veins lying close behind the bronchi are easily torn. All the lower lobe segmental bronchi and those to the middle lobe and lingula parallel the corresponding arteries closely and are easily seen as soon as the artery is divided. In the right upper lobe there is a triple branching of the upper lobe bronchus about one centimeter from the origin of the upper lobe bronchus. The three divisions serving the anterior, posterior, and apical segments are approached from the corresponding side of the hilum of the upper lobe. On the left the apical posterior bronchus and the anterior bronchus to the upper lobe lie under the corresponding artery.

When the bronchus is dissected out, an angled clamp is applied just distal to the point selected for its division. The bronchus is then cut half-way through and an end suture is inserted. A second, and in some instances a third suture is placed to tie over the end of the bronchus. The division of the bronchus is then completed and the end sutures are tied. Ideally, the stump should be closed near to the origin of the bronchus in order not to leave a pocket for the collection of secretions. All bronchi, no matter how small, are accompanied by one or two bronchial arteries and these may require ligation. The bronchial stump is tested for leakage with positive intratracheal pressure and is covered by a flap of adjacent tissue or visceral pleura if possible.

The separation of the segment from its neighbor is now begun. The distal stumps of the artery, vein, and bronchus are grasped with clamps, and slight

traction is applied while the anesthetist inflates the tracheobronchial tree to fill out the adjacent segments and delineate the exact plane between the normal and abnormal. If the course of the vessels and the bronchial tree of the segment to be removed is used as a guide, it is not difficult to tease the segment from its normal neighbor by blunt dissection with the finger or a gauze pledget. The process is made easier by continuous lubrication and washing with saline. Any vein encountered crossing the cleavage plane is ligated and divided. A few terminal bronchioles may have to be stripped out of the remaining surface. When the pleura is reached, it is cut, thus completing the resection.

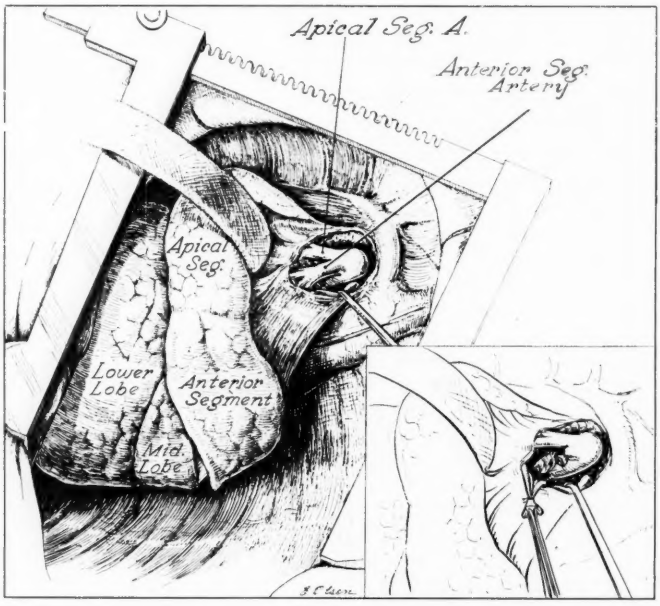


Fig. 1.—The first step in the excision of the right anterior segment. The patient is in the face-down position. The exposure and division of the segmental artery are illustrated.

Usually slight bubbling occurs from the remaining segmental surface, but it stops with the application of a moist pad for a few minutes. Bleeding from the surface has never been a problem. The pleural cavity is washed out with abundant saline and the chest wall is closed. Two catheters are brought out through the incision for underwater drainage with suction applied at a negative pressure of 6 to 10 cm. of water. Care is taken to see that the remaining lung tissue is well filled out as the closure is made.

In an earlier report,[7] illustrations were included which showed the important anatomic relations at the various stages of segmental resection of both the basal segments of the left lower lobe and the lingular segment of the left upper lobe.

In this paper, Figs. 1, 2, 3, and 4 show the stages of resection of the anterior segment of the right upper lobe. Fig. 1 shows the upper lobe retracted caudally,

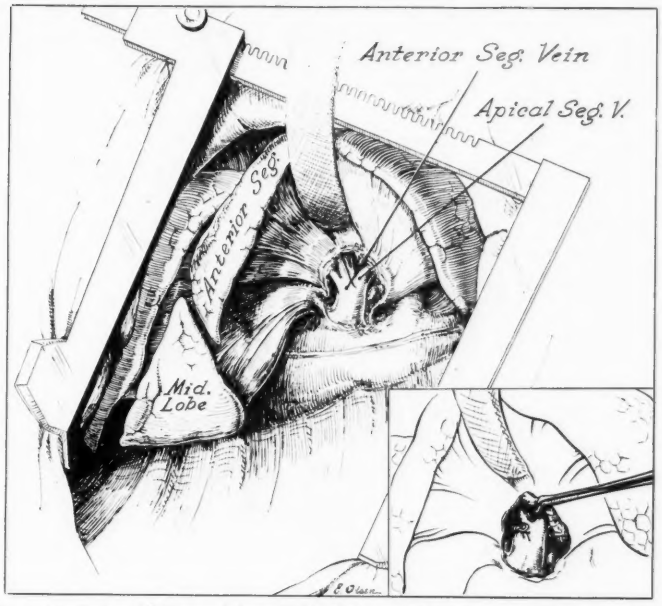


Fig. 2.—The second step in the excision of the right anterior segment. The anterior segmental vein is exposed and divided.

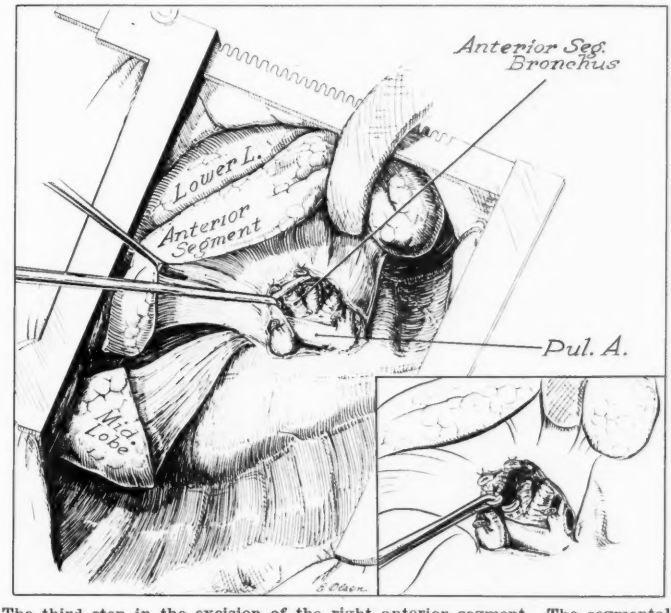


Fig. 3.—The third step in the excision of the right anterior segment. The segmental bronchus is exposed and divided.

exposing the superior aspect of the right hilum. The branches of the right pulmonary artery to the superior and anterior segments of the upper lobe are demonstrated. Insert Fig. 1 shows the branch to the anterior segment divided. Fig. 2 shows the entire lung retracted posteriorly exposing the superior pulmonary vein. The venous tributaries from the upper lobe are dissected out. Insert Fig. 2 shows the tributary from the anterior segment divided. Fig. 3 shows the upper lobe bronchus at its segmental bifurcation exposed by posterior and inferior retraction of the lobe. In Insert Fig. 3 the anterior segmental bronchus is divided. Fig. 4 shows separation of the anterior segment from the neighboring posterior and superior segments. Insert 4 shows the preoperative relations of the anterior segment.

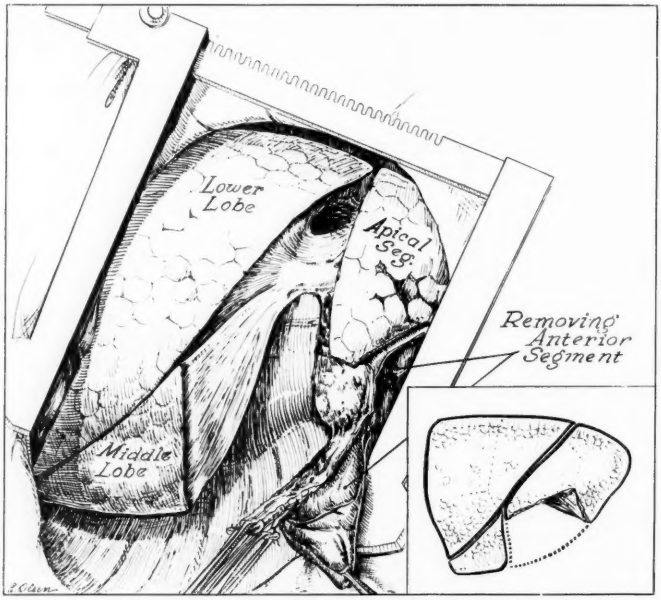


Fig. 4.—The fourth step in the removal of the right anterior segment. The retrograde separation of the segment and development of the intersegmental plane. Note that no lung clamps are used. The insert shows the appearance of the lateral surface of the lung after removal of the anterior segment.

Figs. 5, 6, 7, and 8 show the corresponding stages of resection of the superior segment of the left lower lobe. Fig. 5 shows dissection in the depth of the interlobar fissure. The left pulmonary artery and its segmental branches in the fissure are seen. Insert Fig. 5 illustrates division of the branch to the superior segment of the lower lobe. In Fig. 6 the lower lobe is dropped forward and the inferior pulmonary vein is dissected out. Insert Fig. 6 shows division of the tributaries from the superior segment. Under the divided vein Fig. 7 shows dissection of the branch bronchus to the superior segment of the lower lobe and Insert Fig. 7 shows its division. Separation of the segment is illus-

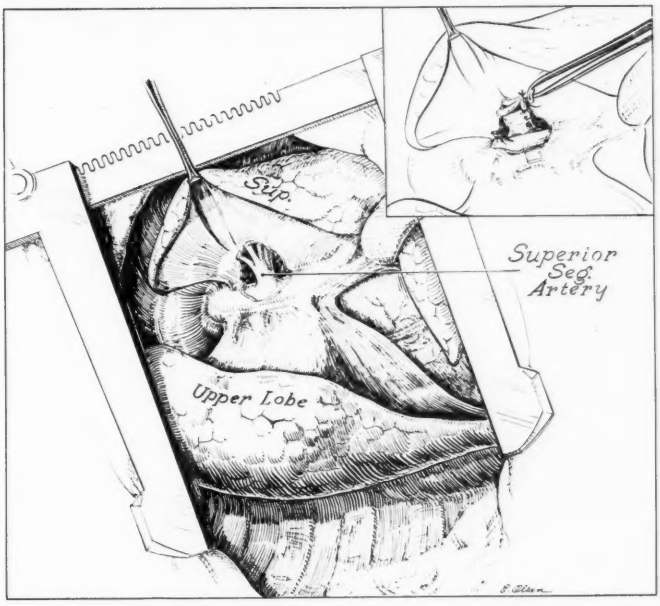


Fig. 5.—The first step in the removal of the superior segment of the left lower lobe. The exposure is shown with the patient in the face-down position. The segmental artery is exposed and the insert shows the vessel after its ligation.

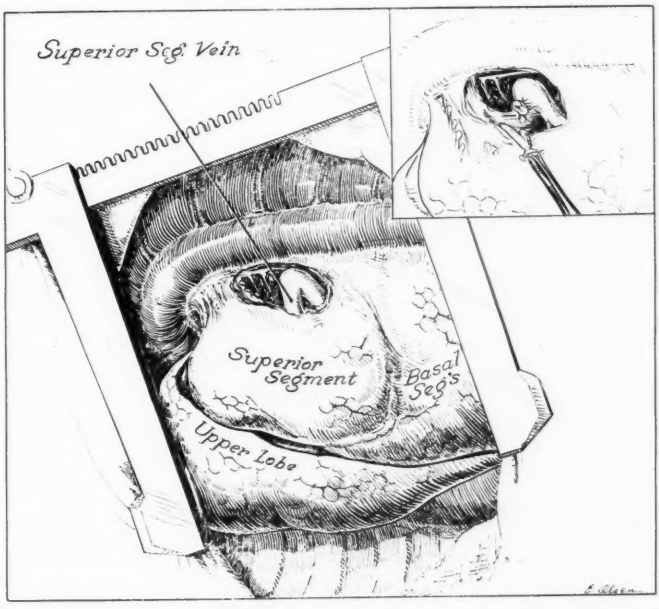


Fig. 6.—The second step in the excision of the superior segment of the left lower lobe. The segmental vein is exposed.

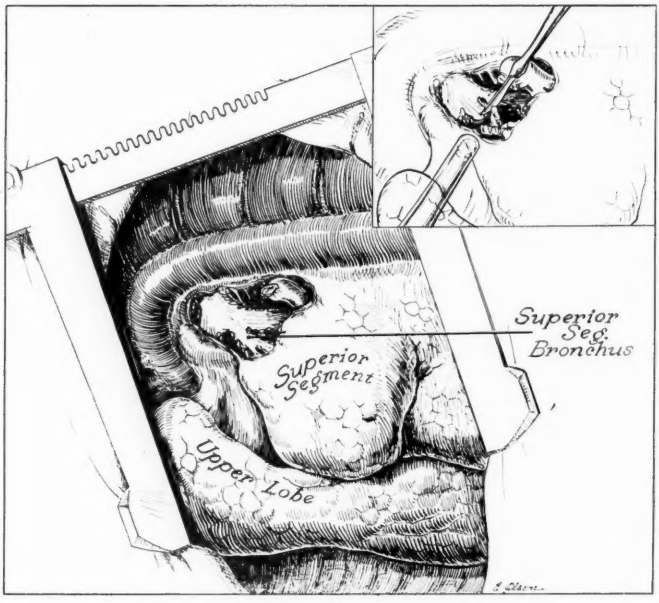


Fig. 7.—The third step in the excision of the superior segment of the left lower lobe. The insert shows the division of the segmental bronchus.

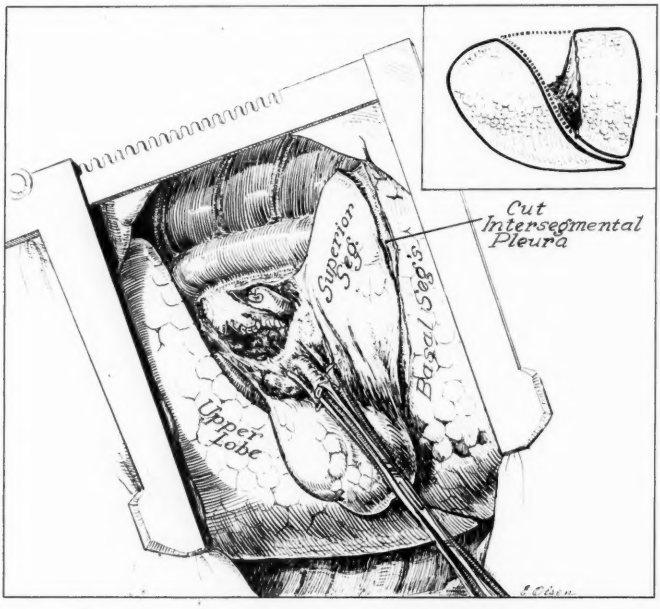


Fig. 8.—The final step in the excision of the superior segment of the left lower lobe. Note that no clamps are being used. The intersegmental plane is developed from the center toward the periphery after the segmental artery, vein, and bronchus, and the visceral pleura have been divided. Note that no lung clamps are used.

trated in Fig. 8 and Insert Fig. 8 shows the original relations of the removed segment.

### POSTOPERATIVE CARE

Postoperative care does not differ from that of routine lobectomies. The primary concern is the maintenance of a good airway and rapid re-expansion of the remaining segments. Oxygen is not usually needed. Coughing is encouraged to bring up secretions. This is often helped by manual support of the chest. Transtracheal suction or less frequently bronchoscopy may be needed if the patient is unable to raise secretions. Signs of atelectasis are watched for and promptly treated. Frequent x-ray or fluoroscopic check of the chest is made to note any pneumo- or hydrothorax. If these cannot be eliminated by manipulation of the tube, chest aspirations are done. The tubes are usually removed in two to three days, but are kept in place if there is evidence of air leak or if the lung has not properly re-expanded.

### SUMMARY OF SEGMENTAL RESECTIONS

From March, 1945, through April, 1947, we have carried out a total of seventy segmental pulmonary resections. Of these, fifty-nine were carried out on fifty patients for bronchiectasis, and eleven were done for other reasons. In the group of patients with bronchiectasis, six additional total lobectomies were carried out, making a total of sixty-five operations in these fifty patients.

### BRONCHIECTASIS

Analysis of the patients with bronchiectasis shows an age range of 7 to 55 years, with seven over 40 years of age. The duration of symptoms ranged up to 48 years. A tabulation of the frequency of involvement of each bronchopulmonary segment in this group is shown in Table I and reveals nearly all the disease in the dependent basal segments of the lower lobes, the lingula, and the middle lobe. A corresponding analysis of the operative procedures in the same group is shown in Table II. It will be noted that in forty of the fifty-nine opera-

TABLE I. FREQUENCY OF INVOLVEMENT OF PULMONARY SEGMENTS IN REPORTED GROUP OF FIFTY CASES OF BRONCHIECTASIS

| LOBE | SEGMENT | NO. OPERATIONS |
|---|---|---|
| Right upper | Anterior | 2 |
| Right upper | Superior | 0 |
| Right upper | Posterior | 0 |
| Right middle | Medial | 23 |
| Right middle | Lateral | 23 |
| Right lower | Superior | 0 |
| Right lower | Basal* | 26 |
| Left upper | Anterior | 1 |
| Left upper | Apical-Posterior | 1 |
| Left upper | Lingula | |
| | Superior division | 27 |
| | Inferior division | 31 |
| Left lower | Superior | 3 |
| Left lower | Basal* | 37 |

*In only one case was the disease limited to one basal segment. In the others there were two or more involved. It has been impossible to determine accurately the extent of involvement of individual basal segments in all cases. Therefore we have grouped them together.

TABLE II. TABULATION OF FIFTY-NINE SEGMENTAL OPERATIVE PROCEDURES FOR BRONCHIECTASIS

| LOBE | SEGMENT | NO. OPERATIONS |
|---|---|---|
| Right lower | Basal group | 4 |
| Right lower | Posterior basal | 1 |
| Right lower and Middle | Basal | 13 |
| Right middle and Right upper | Anterior | 1 |
| Left lower | Basal | 9 |
| Left lower and Lingula | Basal | 22 |
| Lingula | | 2 |
| Left lower and Lingula | Basal<br>Inferior division | 4 |
| Left lower | Superior | 1 |
| Left lower and Lingula | | 1 |
| Lingula and Left upper | Anterior | 1 |

tions segments were removed from more than one lobe. Twenty-four of the fifty patients have proved bilateral bronchiectasis and thirteen have had bilateral operations, although only nine were segmental on both sides.

As might be expected, an increase in complications such as difficulties with re-expansion and fluid accumulations were encountered following segmental resections. We feel, however, that certainly in the presence of bilateral disease, and possibly even in well-localized disease, the conservation of healthy lung tissue well compensated for the added trouble in aftercare. The only death in the group came as a result of a complication unrelated to segmental resection on the second side. At that time we were using fine stainless steel wire to close the bronchial stump. The cut end of a suture eroded through the pericardium into the pulmonary artery, causing a fatal hemopericardium. The use of sutures of wire in segmental bronchi has been discontinued. Empyema occurred fourteen times, or in 23.7 per cent of fifty-nine operations. All except one patient required drainage and he was treated by aspiration and injection of penicillin. Some cases followed known air leaks and others were independent. Three times re-exploration was done because of persistent pneumothorax despite suction drainage. In two the leak was from the segmental surface and in one from a bronchial stump. The average hospitalization was, of course, prolonged. This represents an early experience and covers the developmental period. We are confident that complications will become less frequent with an increase in the skill of carrying out the dissection.

A large proportion of the end results (Table III) have been satisfactory. Those patients who are in good health and are virtually relieved of symptoms are recorded as "good." Those with definite improvement but with some residual sputum are recorded as "improved." Only two are recorded as "poor."

TABLE III. RESULTS IN SEGMENTAL RESECTION OF FIFTY CASES OF BRONCHIECTASIS

| | GOOD | IMPROVED | POOR | INADEQUATE FOLLOW-UP |
|---|---|---|---|---|
| Unilateral cases | 16 | 7 | 0 | 4 |
| Bilateral cases | | | | |
| Unilateral operation | 3 | 4 | 1 | 2 |
| Bilateral operation | 4 | 4 | 1* | 4 |

*This case was the postoperative death.

One of these was the patient who died postoperatively. Ten are recorded as inadequately followed because recent information is not available or they have been operated on within the last three months. As would be expected, the best results are found among those with unilateral involvement: sixteen are good, seven improved, and none poor. Among the bilateral cases with only unilateral operation, three are good, four improved, and one poor. Improvement in this group is expected when second operations are completed on some of those not completely relieved of symptoms. Of the bilateral cases with bilateral operation, four are good, four improved, and one unimproved. The results with unilateral operation for bilateral disease appear comparable to those with bilateral operation because two patients with minimal contralateral disease are completely relieved and another is improved by a unilateral operation. The numbers are of course not statistically significant.

### SEGMENTAL OPERATIONS FOR LESIONS OTHER THAN BRONCHIECTASIS

Segmental resections for lesions other than bronchiectasis have been done eleven times for the following:

| | |
|---|---|
| Tuberculosis | 4 |
| Chronic lung abscess | 3 |
| Pulmonary cyst | 2 |
| Benign tumor | 1 |
| Metastatic tumor | 1 |

These are of sufficient interest to warrant brief abstracts:

CASE 1.—E. M. was a 45-year-old woman with a known history of tuberculosis dating back to 1930. An examination because of pain in the left shoulder and weight loss of forty-four pounds revealed a tuberculoma in the left upper lobe. At operation on Jan. 11, 1946, the lesion was resected with the posteroapical segment of the left upper lobe. No thoracoplasty was done. She did well for several months but developed bilateral reactivation which has, however, responded to sanatorium treatment, and she was in good condition in April, 1947.

CASE 2.—G. F., a 39-year-old man with a history of tuberculosis dating back to 1942, had a large cavity in the left upper lobe. There was little reaction around the cavity and no evidence of disease elsewhere. The lesion with the posteroapical segment was resected March 8, 1946. He developed contralateral and ipsolateral spread postoperatively, and then a tuberculous empyema and bronchopleural fistula. Drainage, thoracoplasty, and attempted closure of the fistula were done April 15, 1946. Despite a prolonged course his general condition is now good, his sputum is negative, the fistula closed, and the chest wall is healed.

CASE 3.—D. J., a 24-year-old woman, gave a five-year history of bilateral tuberculosis. The left-sided disease was quiescent but the right upper lobe contained multiple cavities which did not close despite a good pneumothorax. On Dec. 19, 1945, the right upper lobe was resected together with a nodular superior segment of the lower lobe. This was followed

by a thoracoplasty Feb. 19, 1946. Postoperatively a small pyogenic empyema developed which responded to aspiration and penicillin injections. A period of sanatorium care followed and she was last reported in excellent condition in February, 1947.

CASE 4.—J. S., a 32-year-old woman, gave a nine-year history of tuberculosis. Cough, positive sputum, and weakness persisted. She had a contracted right upper lobe and the superior segment of the right lower lobe under a pneumothorax. On bronchoscopy gross disease was noted in the right upper lobe bronchus. The right upper lobe and superior segment of the lower lobe were removed Oct. 2, 1945. The pathologist reported fibrocaseous tuberculosis without cavitation. Thoracoplasty was done in November, 1945, in two stages. No complications occurred until several months later when a short febrile episode was relieved by coughing up some purulent material probably from a stump abscess. Her condition was reported as excellent in February, 1947.

CASE 5.—E. Q. was a 40-year-old woman with a history of repeated hemoptyses. Appropriate diagnostic study showed a chronic lung abscess which was removed on Jan. 21, 1946, by resection of the superior division and the posterior and medial basal divisions of the right lower lobe. The postoperative course was uneventful and she was in excellent health when last seen just one year later. The pathologic report was actinomycosis. We would have hesitated to do a segmental resection had the etiology been known.

CASE 6.—G. B. was a 34-year-old man with a nine-month history of cough, expectoration, and hemoptysis, in whom a diagnosis of chronic lung abscess was made. The inflammatory tissue was removed by segmental resection of the superior segment of the right lower lobe and the posterior segment of the right upper lobe on Nov. 16, 1945. He developed a mediastinal empyema which was drained on a second admission on Jan. 16, 1946. When last seen Nov. 14, 1946, his condition was excellent.

CASE 7.—J. L. was a 39-year-old man with a five-month history of chronic lung abscess and corresponding findings. The right upper and middle lobes were resected together with the superior segment of the right lower. He developed a fulminating bilateral pneumonia on the fourth postoperative day and died.

CASE 8.—A. M., a 39-year-old man, complained of incapacitating progressive dyspnea following an injury. X-rays showed a bullous cyst seven inches in diameter, filling the left upper chest. At operation Feb. 18, 1947, this was found in the posteroapical segment of the left upper lobe. A segmental resection was done and the normal lung decorticated. There were no complications and he was restored to normal health two months later.

CASE 9.—J. R., an 18-year-old boy, complained only of hemoptysis. A cavity with fluid thought to be an abscess in the superior division of the right lower lobe was drained. At operation May 1, 1947, it proved to be a pulmonary cyst in the posterior segment of the right upper lobe; it was removed with this segment. The postoperative course was uneventful.

CASE 10.—W. F., a 52-year-old man, complained of dyspnea and wheeze. By x-ray a tumor was demonstrated in the superior segment of the left lower lobe. It proved at operation Jan. 25, 1946, to be a hamartoma, and was removed by segmental resection. Eight months later he was in normal health.

CASE 11.—A. T., a 29-year-old woman, complained of chest pain and hemoptysis. X-ray demonstrated a tumor in the lingula. What was diagnosed as a myxofibroma was removed from the heel in 1942. At operation April 29, 1946, a tumor was removed with the lingula. The microscopic diagnosis was liposarcoma. No operative complications occurred. Although asymptomatic, a second metastasis was found and removed Jan. 17, 1947, from the mediastinum. The patient was in good health in April, 1947.

## SUMMARY AND CONCLUSIONS

Our experience with a new method of resection of the pulmonary segment has now been extended to seventy operations. Fifty-nine were for bronchiectasis,

and eleven for other conditions. The method consists essentially of isolating and dividing the artery, vein, and bronchus to the segment, which is then gently teased from its neighbor. The pleura is divided as the final step. The importance of conserving all normal bronchopulmonary segments has been brought out. Among the group with bronchiectasis, the complications have been greater than in total lobectomy. However, the end results have been satisfactory in the great majority of all groups of patients. We therefore feel that certainly in a patient with bilateral disease, segmental resection saving all normal segments is not only justified, but to conserve all possible respiratory function is obligatory. Even in well-localized unilateral bronchiectasis the conservation of normal lung may justify the increased morbidity. In chronic inflammatory processes such as chronic lung abscess or tuberculosis, our limited experience does not warrant a conclusion and we are hesitant to recommend it at present. In noninflammatory processes such as cysts and benign or metastatic tumors, a few experiences have been without complication. We are hopeful of developing a satisfactory method of sealing the raw surface after segmental resection. Pleural flaps, fibrinfoam, or gelatin sponge sheets are possible substances which may be eventually found satisfactory for the purpose.

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## DISCUSSION

DR. RALPH ADAMS, Boston, Mass.—I rise to restate certain historical facts about the technical development of segmental pulmonary resection.

This technique, so beautifully illustrated by a recent article by Overholt and Langer, and described here today by Overholt, Betts, and Woods, was taught to me by Dr. Edward Churchill of Boston in 1938. Dr. Churchill began his segmental pulmonary resection work in 1937, just ten years ago. Most of you, no doubt, remember the article by Churchill and Belsey about that time.

By 1938 the principles of conduct in resecting a division of the lower lobe or a segment other than the lingula of the upper lobe were established and placed in practice by Dr. Churchill. After leaving my assistantship with him at the Massachusetts General Hospital in 1941, I have had opportunity to apply the method in thirty-one cases in the New England Deaconess and Baptist Hospitals.

In seventy-three cases of bronchiectasis, a segmental pneumonectomy of various types was done in thirty-one cases. In the seventy-three cases there were six instances of bronchial fistula with empyema. Four of those occurred in the segmental resections; they all healed spontaneously. The two that failed to heal spontaneously were not in segmental types of resection.

In the seventy-three cases there has been no hospital mortality, and, fortunately, no subsequent mortality.

DR. DAVID H. WATERMAN, Knoxville, Tenn.—Shortly after Dr. Overholt first began using this technique of peeling the segmental portion to be removed away from the hilus, I became interested in it at his suggestion. We have had a much smaller series, only about one-third of his, but have been very enthusiastic about the procedure, and have felt that it has a very definite place.

We feel very strongly that it is a fundamental concept in surgery to preserve all normal tissue possible. Certainly this is true of the lung. We do not know when the patient is going to need that conserved lung tissue later. I think that it is well worth the extra effort and trouble to save it.

At this stage of the game, we also feel that if we can become proficient enough at resecting these segments in the good-risk patient, we will later be able to take care of severe bilateral bronchiectasis patients who would otherwise be inoperable if the uninvolved segments were not saved. In our own experience we know we have gotten through a number of patients who could not have survived complete lobectomy with its resultant loss of functional tissue.

We have not used the operation in children before the age of puberty, feeling that probably the additional risks, both in length of surgery and in complications were not warranted, since the normal hypertrophy of lung tissue coincident with chest enlargement would compensate adequately.

We have never bothered to use it on middle lobes or in tuberculosis patients, but have used it in lung abscesses, particularly in removing the apex of the lower lobe.

We agree there are more complications, as Dr. Woods has pointed out. We have had the same trouble he has had with leakage from the denuded surface. Oxycel-gauze left in place has been of aid.

We have also had a little more trouble, I think, with atelectasis of the remaining segments of the operated lobe. The first case we did, in which we preserved a superior segment of a lower lobe, required two bronchoscopies postoperatively. The lower lobe would drop down, kink, and become atelectatic, but would aerate after bronchoscopy. Subsequent to that time, when we have preserved a superior segment of a lower lobe, we have placed sutures along the fissure to keep it in place. Since then we have never had this complication.

One important step in technique, and I know Dr. Overholt and his associates subscribe to it, is the ligation of the bronchus as close to the preserved branch as possible. On our third case, in removing basilar segments of the lower lobe, we ligated too low, leaving a stump below the superior division. The patient, although clinically much benefited, had a massive hemoptysis some months after surgery. We were in the embarrassing position of having to operate again to remove the stump.

DR. PAUL C. SAMSON, Oakland, Calif.—Anatomic segmental resection and its surgical refinements, such as have been demonstrated today are, I believe, a definite addition in the treatment of bronchiectasis.

In the past few months, Dr. Dugan and I have had the opportunity of using this technique in some fifteen cases. All were for bronchiectasis, except one for chronic lung abscess in an apical segment of the right lower lobe and one for tuberculosis, in which the right upper lobe, middle lobe, and the apical and subapical segments of the lower lobe were removed.

I believe it will be of interest to show two films which demonstrate the fact that bronchograms must be made with great accuracy if we are to delineate these segments.

(Slide.) Shown here is an example of a probable post-abscess bronchiectasis, in the ordinary frontal view. The exact location of the bronchiectasis cannot be told from this projection, but in the lateral view it is obviously in the apical (or superior) segment of the lower lobe.

In bronchography, I think one should stress—when we are delineating segments—that the lateral roentgenogram is only of value when one side is filled at a time.

(Slide.) This is a particularly good demonstration, as was shown in the movie, of what happens to an apical segment when it distends following disease and shrinkage in the basal segments. We see again a small amount of bronchiectasis in the lower lobe on the right side. In the lateral projection we see that it is limited to the basal segments, and here is a large apical segment which occupies, as you can see, a very considerable proportion of the lower section of the chest. Even though it was a one-sided lesion, in an effort to increase our technical ability, a segmental resection of the basal segments was done, and this apical segment expanded very well, and on the table reached the diaphragm.

As the essayists have pointed out, the complications are somewhat more frequent if segmental resection is done. We have not found that they have been particularly serious, but one must expect a slightly increased number of patients who have excessive secretions in their bronchial tree following operation, a slightly increased number of patients who have minor air leaks, and, I believe, a definitely increased number of localized empyemas.

In a series of over 150 consecutive lobectomies which Dr. Dugan and I have done, we have had five empyemas in the total series. Three of those were associated with the group in which segmental resections were done.

DR. F. M. WOODS, Boston, Mass.—We have not, as I said, had particular difficulty with re-expansion of the remaining segments. However, on a number of occasions we have had to do bronchoscopies for transient atelectasis or for patients who had difficulty in raising secretions. The obvious defect in this procedure, of course, is the raw surface which is left after the segmental resection, and it is to be hoped that in the future some satisfactory method will be developed to cover this so that leaks and the egress of infection from the tracheobronchial tree can be satisfactorily taken care of, and convert this into an operation as safe as a total lobectomy.

# EXPLORATORY THORACOTOMY IN THE MANAGEMENT OF INTRATHORACIC DISEASE

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MAJOR MARTIN L. BRADFORD,† MEDICAL CORPS, ARMY OF THE UNITED STATES (BY INVITATION), AND
COLONEL HUGH W. MAHON,‡ MEDICAL CORPS, REGULAR ARMY (BY INVITATION)

DURING recent years mass x-ray surveys have been extended by both governmental and private agencies to the point that there is scarcely an individual in the United States who lacks the opportunity to have a chest examination by x-ray. The experience gained from such studies indicates that among apparently normal working adults, approximately 1.4 per cent are found to give x-ray evidence of reinfection tuberculosis and one in eighty-nine show abnormal nontuberculous findings. Studies of consecutive hospital admissions reveal that 8 to 10 per cent of patients admitted to a hospital have evidence of thoracic disease.

It is apparent that this means of discovering pathologic lesions in apparently healthy persons at a stage prior to the onset of symptoms presents an exciting opportunity to chest surgeons for the early diagnosis and treatment of malignant neoplasms. It is at the same time a challenge to the medical profession to clarify its ideas concerning differential diagnosis and treatment of intrathoracic lesions. Time is precious and procrastination is disastrous. Each clinical problem must be approached in an orderly way and brought to definitive treatment as expeditiously as possible. It is the purpose of this communication to discuss the information derived from accepted methods of differential diagnosis and to evaluate the place of exploration of the thorax in the management of obscure lesions of the chest.

## EXPERIENCE

During the period between September, 1942, and April, 1947, there were 200 exploratory thoracotomies of the chest performed for obscure intrathoracic disease at Fitzsimons General Hospital, Denver, Colo. Table I shows the location of the lesions explored and indicates the number and percentage of malignant tumors discovered. Table II reveals the pathologic diagnoses of the tissues removed.

The patients in this series were predominantly male and approximately 90 per cent were men in service in World War II. The other 10 per cent were veterans of World War I. (See Figs. 1 to 19.)

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From the Surgical Service of Fitzsimons General Hospital, Denver, Colo.
Read at the Twenty-Seventh Annual Meeting of The American Association for Thoracic Surgery, St. Louis, Mo., May 28, 29, and 30, 1947.

*Chief of Surgical Service, Fitzsimons General Hospital.
†Chief of Chest Surgery Section, Fitzsimons General Hospital.
‡Chief of the Laboratory Service, Fitzsimons General Hospital.

TABLE I. EXPLORATORY THORACOTOMY

| LOCATION OF LESIONS | NO. CASES | NO. MALIGNANCIES | PER CENT |
|---|---|---|---|
| I. Mediastinal | 73 | 12 | 16.4 |
| II. Intrapulmonary | 113 | 29 | 25.6 |
| III. Extrapulmonary (Exclusive of mediastinal and vascular) | 8 | 2 | 25.0 |
| IV. Heart and great vessels | 6 | 0 | 0 |
| Total | 200 | 43 | 21.5 |

TABLE II. EXPLORATORY THORACOTOMY

| PATHOLOGIC DIAGNOSIS | | NUMBER | |
|---|---|---|---|
| I. Mediastinal Lesions | | | 73 |
| A. Lymph nodes | | 24 | |
| 1. Hodgkin's | 3 | | |
| 2. Lymphoma, giant follicular hyperplasia | 1 | | |
| 3. Boeck's sarcoid | 6 | | |
| 4. Tuberculous lymphadenopathy | 8 | | |
| 5. Mediastinitis | 6 | | |
| B. Congenital cysts | | 22 | |
| 1. Dermoid | 3 | | |
| 2. Teratoma | 3 | | |
| 3. Pericardial celomic | 8 | | |
| 4. Bronchial | 7 | | |
| 5. Esophageal | 1 | | |
| C. Acquired cyst | | 1 | |
| 1. Cystic hematoma | 1 | | |
| D. Tumors | | 25 | |
| 1. Connective tissue | 4 | | |
| 2. Neurogenic | 8 | | |
| 3. Thymic | 7 | | |
| 4. Esophageal | 1 | | |
| 5. Primary carcinoma | 5 | | |
| E. Intrathoracic goiter | | 1 | |
| II. Intrapulmonary Lesions | | | 113 |
| A. Tuberculosis | | 40 | |
| 1. Active | 16 | | |
| 2. Tuberculoma | 24 | | |
| B. Bronchogenic tumor | | 29 | |
| 1. Malignant | 24 | | |
| 2. Benign | 5 | | |
| C. Hamartoma | | 1 | |
| D. Primary sarcoma | | 1 | |
| E. Metastatic carcinoma and sarcoma | | 1 | |
| F. Amoebic abscess | | 1 | |
| G. Congenital bronchogenic cyst | | 13 | |
| H. Parasitic lesion | | 1 | |
| 1. Taenia echinococcus | 1 | | |
| I. Fungus lesion | | 6 | |
| 1. Actinomycosis | 2 | | |
| 2. Blastomycosis | 1 | | |
| 3. Coccidioidomycosis | 3 | | |
| J. Pneumonitis | | 13 | |
| K. Atelectasis | | 3 | |
| L. Aneurysm | | 1 | |
| M. Interlobar empyema | | 2 | |
| N. Apical empyema | | 1 | |
| III. Extrapulmonary Lesions | | | 8 |
| A. Pleural malignancy | | 1 | |
| B. Liver abscess | | 2 | |
| C. Diaphragmatic hernia | | 3 | |
| D. Tumor of diaphragm | | 1 | |
| E. Tuberculous granuloma of pleura | | 1 | |
| IV. Heart and Great Vessel Lesions | | | 6 |
| A. Aneurysm of heart | | 1 | |
| B. Aneurysm of great vessels | | 5 | |

Fig. 1.

Fig. 2.

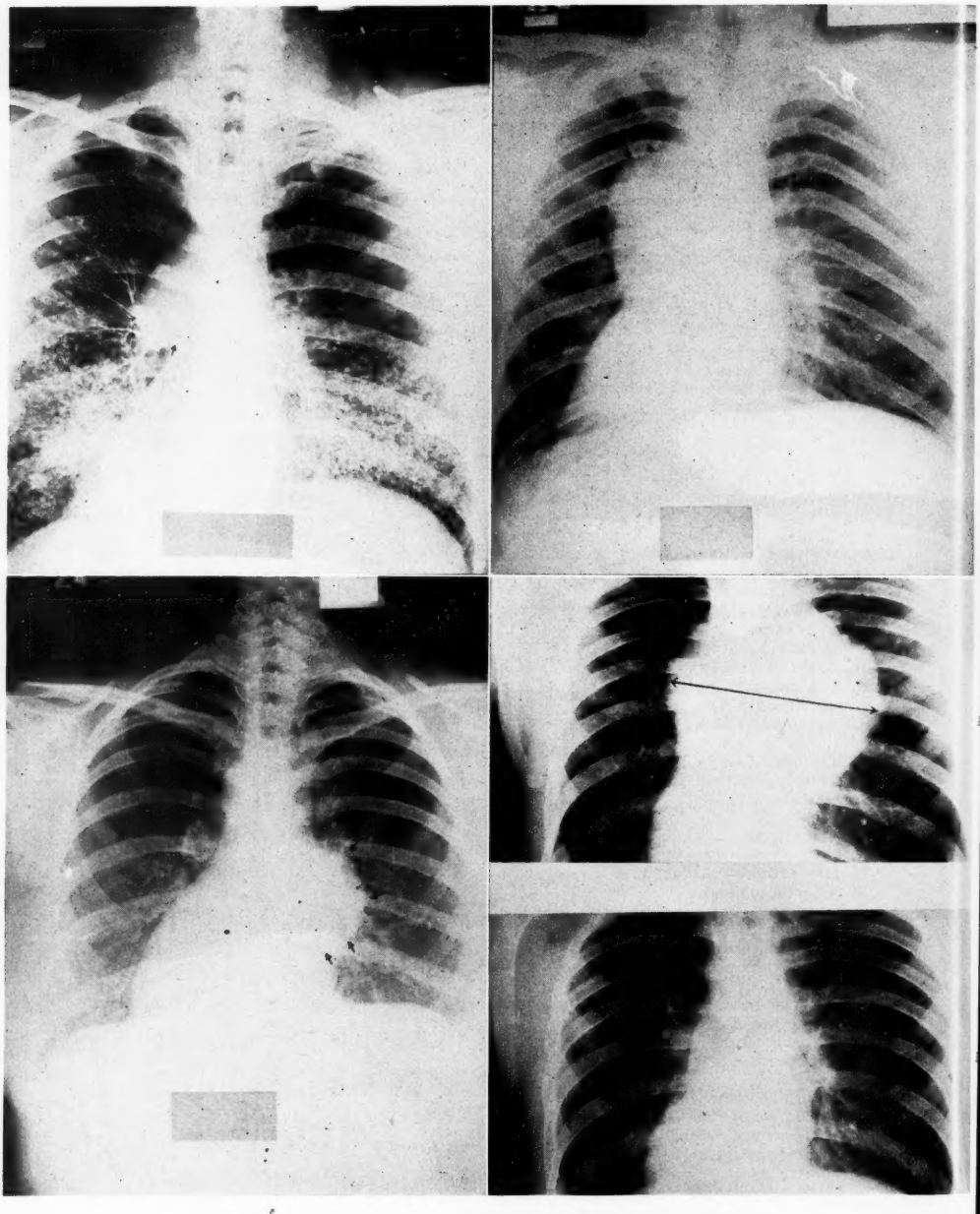


Fig. 3.

Fig. 4.

Mediastinal Lesions

Fig. 1.—Giant follicular hyperplasia.
Fig. 2.—Benign teratoma.
Fig. 3.—Intrathoracic goiter.
Fig. 4.—Thymic carcinoma. *A*, Before x-ray therapy; *B*, response to x-ray therapy.

Fig. 5.

Fig. 6.

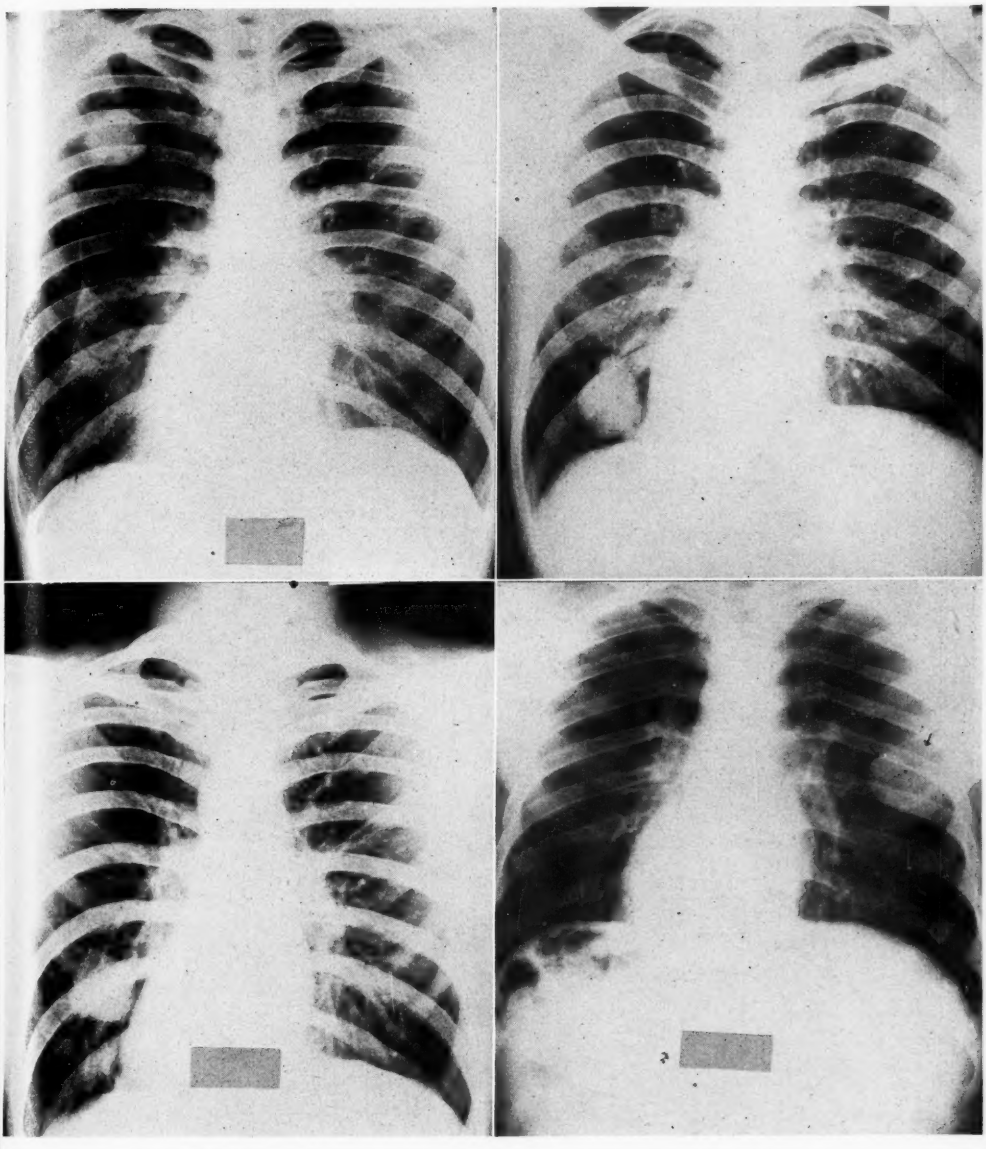


Fig. 7.

Fig. 8.

Intrapulmonary Lesions, Benign

Fig. 5.—Coccidioidomycotic granuloma.
Fig. 6.—Venous aneurysm, left inferior pulmonary vein.
Fig. 7.—Congenital bronchogenic cyst.
Fig. 8.—Parasitic lesion taenia echinococcus.

Fig. 9.

Fig. 10.

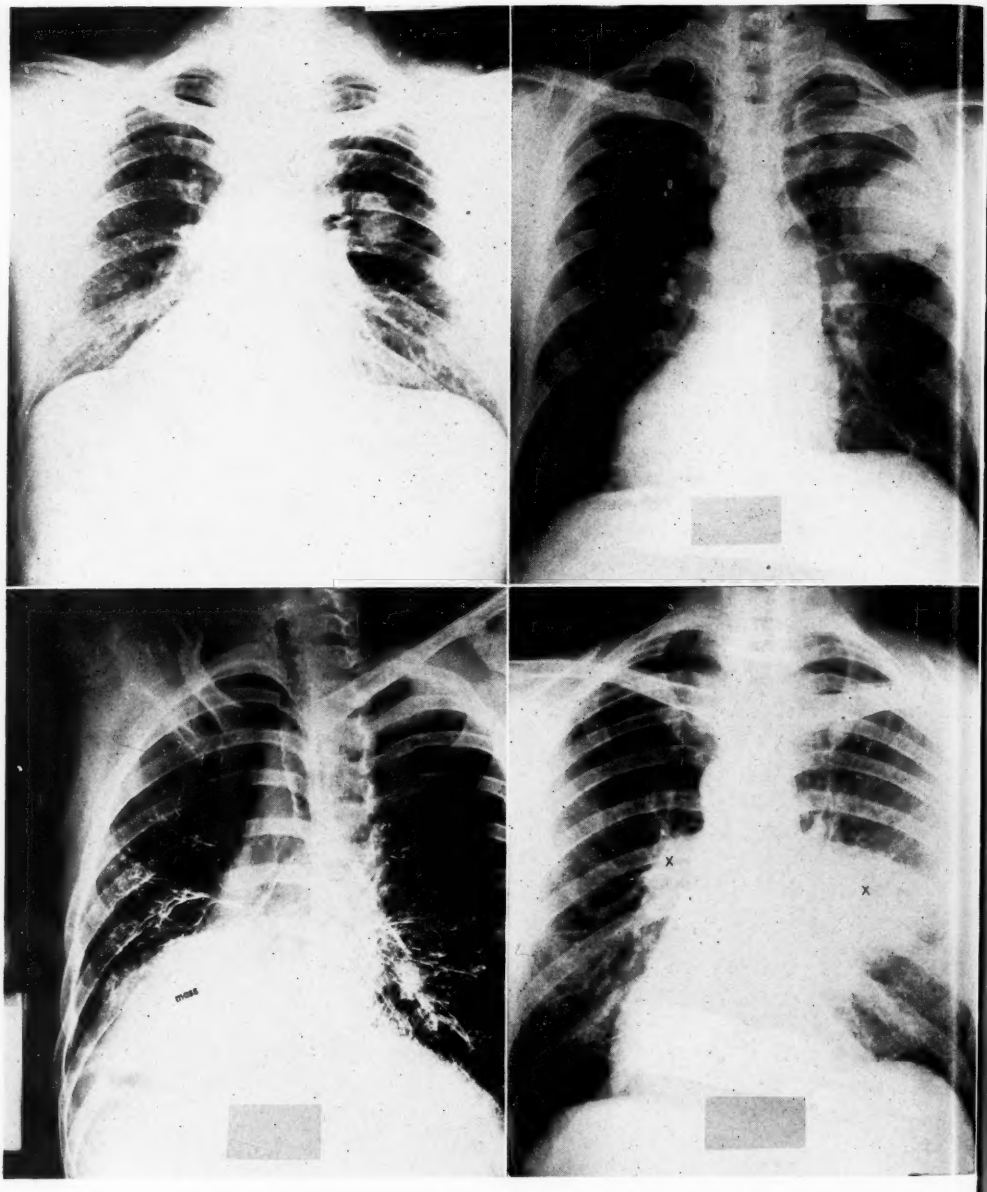



Fig. 11.

Fig. 12.

Intrapulmonary Lesions, Malignant

Fig. 9.—Adenoma.
Fig. 10.—Bronchogenic adenocarcinoma.
Fig. 11.—Fibrosarcoma.
Fig. 12.—Bronchogenic squamous-cell carcinoma.

Fig. 13.

Fig. 14.

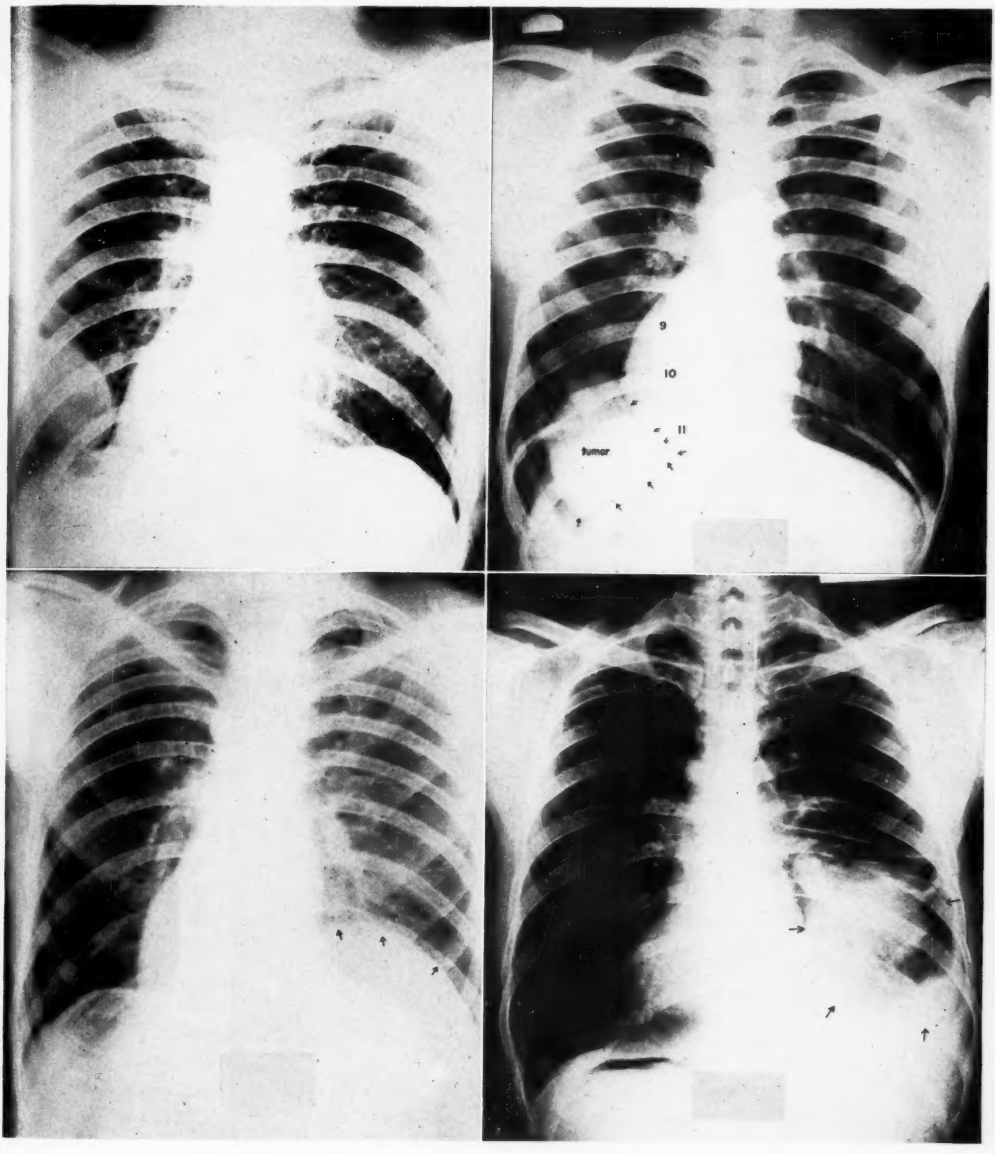
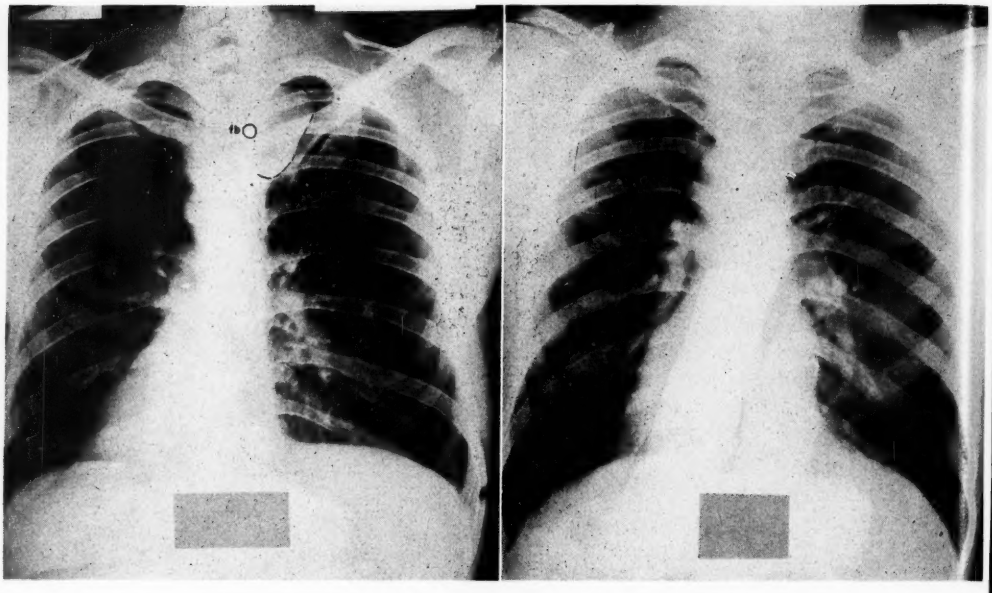



Fig. 15.

Fig. 16.

Extrapulmonary Lesions, Nonmediastinal or Vascular

Fig. 13.—Diaphragmatic omental hernia.
Fig. 14.—Fibroangioendothelioma of diaphragm.
Fig. 15.—Liver abscess.
Fig. 16.—Endothelioma of pleura.



Heart and Great Vessel Lesions

Fig. 17.—Traumatic aneurysm, innominate artery (outlying foreign body lodged in spine).
Fig. 18.—Congenital aneurysm of aorta.

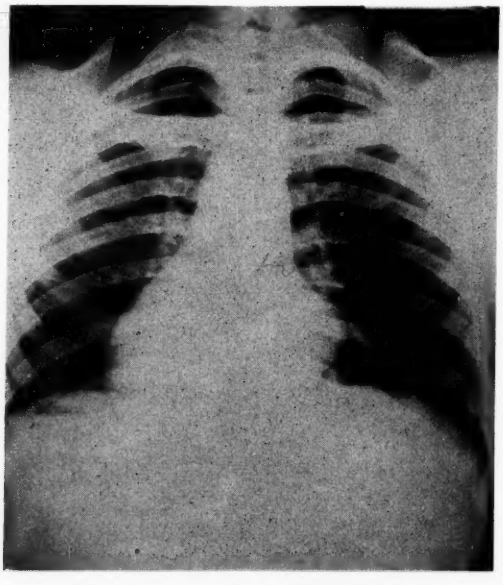


Fig. 19.—Aneurysm of right ventricle.

### HISTORY AND PHYSICAL EXAMINATION

The studies of Gebauer[10] indicate that the symptoms of bronchogenic carcinoma have their onset early in the disease. However, the impression gained from this group of cases is that the symptoms of thoracic neoplasms are either absent or of such low intensity early in the disease that they are of negligible value either for causing the patient to consult his physician or for impressing the physician with the seriousness of the malady.

Except for the fortunate patient who develops bronchial obstruction with secondary pulmonary suppuration early in the disease, physical examination is not contributory until the patient has reached the stage where he is of interest only to the statistician and the pathologist. In an occasional case, a localized wheeze or segment of atelectasis may prove extremely valuable in directing attention to an early lesion. In the presence of mediastinal enlargement, careful examination of the superficial lymphatics may reveal an enlarged node which by biopsy may indicate the diagnosis.

### LABORATORY EXAMINATION

Studies of bronchial secretions stained with the Papanicolaou stain[5] indicate that a high percentage of pathologic diagnoses of bronchogenic cancer can be made by those trained in this technique. For example, Clerf and Herbut[5] were able to make a positive diagnosis in 82.4 per cent of a series of fifty-seven cases of proved bronchogenic carcinoma in which bronchoscopic biopsy was positive in only 42.1 per cent. The ability to differentiate malignant from nonmalignant cells in such stained smears is difficult to acquire, but with added experience this technique should prove to be a valuable addition to our diagnostic armamentarium.

The laboratory diagnosis of tuberculosis, coccidioidomycosis, histoplasmosis, infectious mononucleosis, and blood dyscrasia is mentioned because such tests may assume an important place in the differential diagnosis. Tests of this type do not exclude tumor since a malignant neoplasm may be associated with any of the conditions noted previously. Negative tests frequently assume considerable importance in excluding these conditions which are frequently mimicked by malignant new growths.

### ROENTGEN DIAGNOSIS

As Overholt[20] has said so succinctly, "Surveys find but do not necessarily identify disease." In spite of fluoroscopy, position studies, stereoscopic roentgenograms, Potter-Bucky technique, laminographs, and diagnostic pneumothorax, roentgenography can do little beyond placing the lesion in certain pattern groups and localizing its position. Exceptions are the dermoid cysts containing a dental ridge with teeth, diodrast visualization of the great vessels, and diaphragmatic hernia demonstrated by diagnostic pneumoperitoneum.

*Circumscribed Lesions.*—Numerous authors have pointed out the potential malignancy of the circumscribed intrapulmonary lesions. Cancer is present frequently enough that every such lesion must be considered malignant until

proved otherwise. All lesions belonging to this group are sharply circumscribed, located in the periphery of the lung, globular in form, and entirely without diagnostic characteristics. It is only when another physician has erred that one has the opportunity to study serial roentgenograms to determine growth characteristics. Lesions of this type located near the diaphragm present a special differential diagnostic problem as diaphragmatic hernias containing liver or omentum must also be taken into consideration.

Of our 200 cases, 79 were lesions of the mediastinum, heart, and great vessels. Of the remaining 121 cases, exploration was carried out in 86 for circumscribed lesions. Round tuberculous foci constituted the largest segment of this group and accounted for 37 cases. Intrapulmonary fluid-filled bronchogenic cysts of which there were 13 cases were third in frequency. There were three coccidioidomycotic granulomas. Three diaphragmatic hernias were not diagnosed preoperatively because they contained no hollow viscus and pneumoperitoneum was not carried out. Two liver abscesses produced circumscribed shadows in the region of the right diaphragm. There was 1 echinococcus cyst and 1 arteriovenous aneurysm. Of 30 intrapulmonary malignant tumors diagnosed by operation, 18 were classified as round, circumscribed lesions from the roentgenograms. Of these 18 cases, 4 were adenomas, 1 was a primary pulmonary sarcoma, and 13 were bronchogenic carcinomas. In addition, there was 1 angioendothelioma of the diaphragm and 1 pleural carcinoma which presented smooth circumscribed outlines. From this group of 86 circumscribed lesions there were 20 malignant tumors, or 23 per cent.

*Atelectasis.*—The "pie-piece" or pyramidal shadow of atelectasis with or without evidence of pulmonary suppuration is typical only of bronchial obstruction which may be caused by cancer, adenoma, foreign body, benign bronchial tumor, tuberculous bronchitis, nonspecific granuloma, cicatricial stenosis, or extrinsic pressure on the bronchus. Bronchograms, in such cases, show the point of bronchial obstruction but not its cause.

In this group there was a total of 35 cases. Of these, 16 were due to nonspecific pneumonitis or benign bronchial stenosis. There were 3 cases of tuberculosis with segmental atelectasis which were not diagnosed preoperatively because the bronchial obstruction prevented recovery of the tubercle bacilli from the sputum. There was 1 case of obstruction of a tertiary bronchus by a benign squamous papilloma. The most significant cause of bronchial obstruction was bronchogenic carcinoma which comprised 11 cases, or 31 per cent.

*Mediastinal Tumors.*—With the exception of dermoid cysts containing teeth previously mentioned, there is little characteristic of the roentgen appearance of the various types of mediastinal tumors. The position and relationships of the tumor are valuable from a percentage standpoint but cannot identify individual tumors. The smooth outline of a mediastinal cyst or tumor may be confused with a similar outline of a malignant lymphoma or a Boeck's sarcoid. The posteriorly placed circumscribed mass may appear to be a neurofibroma or an esophageal cyst but may in reality be an aberrant thyroid adenoma or a bronchogenic cyst. (See Table III.)

TABLE III. ROENTGEN APPEARANCE
(200 Cases of Exploratory Thoracotomy)

| | NUMBER | PER CENT | NUMBER | PER CENT |
|---|---|---|---|---|
| I. Circumscribed Lesions of Pulmonary Parenchyma | | | 86 | 43.0 |
| A. Round tuberculous foci | 37 | 43.0 | | |
| 1. True tuberculoma, 24 | | | | |
| 2. Caseous tuberculosis, 11 | | | | |
| 3. Tuberculous granuloma, 2 | | | | |
| B. Fluid-filled bronchogenic cyst | 13 | 15.1 | | |
| C. Coccidioidomycotic granuloma | 3 | 3.4 | | |
| D. Diaphragmatic hernia | 3 | 3.4 | | |
| E. Liver abscess | 2 | 2.3 | | |
| F. Echinococcus cyst | 1 | 1.2 | | |
| G. Arteriovenous aneurysm | 1 | 1.2 | | |
| H. Hamartoma | 1 | 1.2 | | |
| I. Metastatic sarcoma | 1 | 1.2 | | |
| J. Actinomycosis | 1 | 1.2 | | |
| K. Asymptomatic empyema | 3 | 3.4 | | |
| L. Primary malignancy | 20 | 23.0 | | |
| II. Atelectasis | | | 35 | 17.5 |
| A. Chronic nonspecific pneumonitis | 16 | 45.7 | | |
| B. Tuberculosis | 3 | 8.5 | | |
| C. Benign squamous papilloma | 1 | 2.8 | | |
| D. Amoebic abscess | 1 | 2.8 | | |
| E. Actinomycosis | 1 | 2.8 | | |
| F. Blastomycosis | 1 | 2.8 | | |
| G. Empyema | 1 | 2.8 | | |
| H. Bronchogenic carcinoma | 11 | 31.4 | | |
| III. Mediastinal Lesions | | | 73 | 36.5 |
| A. Benign | 61 | 83.5 | | |
| B. Malignant | 12 | 16.4 | | |
| IV. Heart and Great Vessels | | | 6 | 3.0 |
| A. Benign | 6 | 100 | | |

## BRONCHOSCOPY

The medical literature is replete with reports indicating that bronchogenic carcinoma can be diagnosed bronchoscopically in 70 to 90 per cent of cases at some time during the life of the patient. However, the limitations of bronchoscopy in the diagnosis of the early lesions have not been sufficiently emphasized. A recent survey of 100 consecutive cases of cancer of the lung in our hospital, proved by surgical removal of the lesion or autopsy, has shown that the primary lesion was located in the bronchoscopically visible portion of the bronchial tree in 43 per cent of the cases. In 57 of the 100 cases the primary lesions could not have been seen or biopsied by bronchoscopy.

Bronchoscopically proved cases of lung cancer are less frequently resectable than the peripheral lesions. Koletsky[16] has called attention to the fact that the anaplastic epithelioma (small or oat-cell carcinoma) involves the stem bronchus in 70 per cent of the cases and is most readily diagnosed bronchoscopically. There is no record in the medical literature of a cancer of this type being cured by pulmonary resection. Of the squamous-cell carcinomas, Gebauer[10] noted that 49 per cent originate in the upper lobe or small branch bronchi where they are not accessible for biopsy until late. This type is the tumor most favorable for resection. Lindskog[17] recently reported a series of 100 bronchogenic carcinomas of which all but 32 were considered inoperable. Of the 32 patients explored, there were positive bronchoscopic biopsies in only 12 cases, or 37 per cent.

In 12 cases, resection was carried out and of these only 2 had a preoperative bronchoscopic biopsy. In Gebauer's series a positive bronchoscopic biopsy was obtained in only 17 per cent of the resectable cases of bronchogenic carcinoma.

Of the 44 cases of pulmonary carcinoma resected in our hospital during the period of this report it was possible to make a preoperative bronchoscopic diagnosis in 20, or approximately 45 per cent. From these facts we conclude that a positive bronchoscopic diagnosis can be made in less than one-half of the operable cases of lung cancer.

In the so-called bronchial adenomas, Holley[14] reported 38 cases in which all but 6, or approximately 85 per cent, were discovered by bronchoscopic examination.

We have seen 12 cases of this type during the period of this report and were able to diagnose 7 of them bronchoscopically. It would appear that adenomas are more frequent in the stem bronchi and that the bronchoscope is quite efficient for their discovery.

### DIAGNOSTIC X-RAY THERAPY

Thoracic physicians and surgeons agree, in general, that the use of diagnostic x-ray therapy for possibly removable intrathoracic neoplasms is distinctly harmful since many malignant tumors do not respond to irradiation and, in those that do improve, the malignant nature of the lesion has been established at a cost of a loss of valuable time. A consistent exception to this policy has been made in those lesions suspected of belonging to the lymphoblastoma group. In the past, a response to a "test dose" of x-ray therapy was considered as sufficient diagnostic proof to call the lesion "malignant lymphoma" with its grave prognostic significance. Exploratory thoracotomy was considered too extensive a procedure to justify a diagnosis by pathology. The risks of thoracic exploration have now decreased so sharply that we are re-examining this subject. It has been our experience that the slight risks involved are far outweighed by the benefits to the patient of a diagnosis based on the histology of the lesion, prompt institution of a proper therapeutic regimen, and an increase in the physician's knowledge of the nature of the lesion.

*Histology and X-ray.*—When confronted with lymphadenopathy apparently confined to the mediastinum, one must consider various forms of lymphoma: giant follicular lymphoma, reticulum-cell sarcoma, lymphosarcoma, and Hodgkin's disease, as well as the mediastinal cysts and tumors, tuberculosis, histoplasmosis, sarcoidosis, carcinoma, chronic inflammation, infectious mononucleosis, syphilis, leucemia and certain other conditions.

All members of this group are to some degree sensitive to irradiation. The results of irradiation, however, vary within wide and unpredictable limits. This is best illustrated by Hodgkin's disease, in which certain types with a high connective tissue content are almost entirely radioresistant while other types principally lymphocytic in origin respond dramatically to a very small amount of irradiation. Blades[4] has stated that 750 R. constitutes an average test dose

but estimates that one-fourth to one-third of cases of malignant lymphoma require as much as 1,500 R. to affect the tumor. We have recently seen a case of proved mediastinal Hodgkin's disease in which the mediastinal tumor continued to increase in size while the patient was getting a full therapeutic dose of x-ray therapy. Response to x-ray irradiation would therefore seem an extremely slender reed upon which to rest a diagnosis with the prognostic significance of any of the lymphoblastoma group.

A favorable response to irradiation is by no means a characteristic limited to the malignant lymphomas. Certain tumors of the thymus, indistinguishable roentgenographically from the lymphoblastoma group, are quite sensitive to x-ray therapy. These tumors may be quite late to metastasize and offer an opportunity for cure if recognized at an early stage and removed by surgery. A response to x-ray in such cases leads not only to an erroneous diagnosis but also may mean the loss of opportunity for complete surgical removal of the lesion.

In sarcoidosis, rapid spontaneous remission may cause large masses of mediastinal nodes to decrease until they are hardly visible. Should such an occurrence coincide with a period of x-ray therapy and thereby inspire a diagnosis of radiosensitive lymphoblastoma, the implications are dangerously evident.

*Hazards.*—Following therapeutic irradiation, normal cleavage planes are fibrosed and distorted to the point that surgical removal of the lesion is vastly more difficult. This, of course, varies with the amount of therapy given. Since no general agreement has been reached as to what constitutes a "test dose," 2000 R is frequently exceeded. In such instances, attempts at surgical removal of the lesion become distinctly hazardous.

Following x-ray therapy, an accurate histologic diagnosis from stained sections of the lesions is usually not possible because of the cytolytic effect of the irradiation which may have destroyed the characteristic cells on which the diagnosis rests.

*Localized Lymphoma.*—The diagnosis of any type of lymphadenopathy must rest on a properly executed biopsy. When the mediastinal involvement is part of a generalized disease, a peripheral node may easily be taken for this examination. While it is true that the superficial lymph nodes are sooner or later almost invariably involved, at the beginning the disease develops in the nodes of a single region; then during subsequent exacerbations it spreads to other groups of lymph nodes. This first or localized stage of a malignant lymphoma may originate in any set of nodes, but usually involves an internal group. Symmers[25] stated that primary enlargement of abdominal or of abdominal and thoracic nodes combined is ten times more common than primary enlargement of cervical nodes. Ewing[8] supported this view, adding that the superficial nodes which first attract attention are merely the outlying portions of an internal lesion. During this first stage, the most common site of deep adenopathy is the mediastinum. Enlarged mediastinal nodes are readily demonstrated by routine roentgenograms of the chest and this often offers the opportunity for early diagnosis and institution of therapy. Too frequently this opportunity is lost by procrastination.

### THE RISKS OF EXPLORATORY THORACOTOMY

As would be expected, the risk of surgical exploration of the chest is dependent upon the therapeutic portion of the operation. There were no deaths in this series attributable to exploration per se. Eight deaths occurred in the 200 cases reported here as a result of postoperative complications. Of these, 5 were in pneumonectomies performed for cancer, 3 of pulmonary edema and 2 of bronchopleural fistulas. One additional death from pulmonary edema occurred following pneumonectomy for blastomycosis. There was 1 death in the 56 lobectomies reported in this series, this due to bronchopleural fistula. The remaining death was due to massive hemothorax from an inoperable neurogenic sarcoma.

In addition to the postoperative complications noted here, there were 12 pleural effusions requiring from one to three thoracenteses, 5 cases of atelectasis treated by bronchoscopy, 3 minor wound infections, and 4 empyemas.

### SUMMARY AND CONCLUSIONS

Mass x-ray surveys have vastly increased the opportunities for early discovery of thoracic lesions, frequently prior to the onset of symptoms. This presents a challenge to thoracic surgeons to make an early diagnosis. The conservative diagnostic measures should be employed as expeditiously as possible, recognizing their limitations, but in obscure cases early thoracic exploration is indicated.

We present 200 cases of exploratory thoracotomy performed for the diagnosis and treatment of obscure intrathoracic disease. In this series of consecutive cases, malignant tumors occurred in 21.5 per cent, or approximately 1 in 5 cases.

The limitations of bronchoscopic diagnosis have been emphasized and evidence presented to show that, in resectable cases, positive bronchoscopic biopsy can be expected in less than 50 per cent of the lesions. Therefore a negative bronchoscopy is of no value in excluding intrathoracic neoplasm.

The accepted practice of using x-ray therapy as an adjunct in the diagnosis of malignant lymphomas is condemned because:

1. All malignant lymphomas do not respond to x-ray therapy.
2. Many benign lymphadenopathies and resectable malignant lesions of the thymus do respond to irradiation and would lead to an erroneous diagnosis.
3. There are indications that the prognosis of localized mediastinal lymphoma is improved by combined resection and irradiation therapy.
4. The prompt establishment of a histologic diagnosis expedites initiation of treatment.

Of the 86 circumscribed parenchymal lesions, 20 were found to be malignant. This emphasizes the necessity of early exploration in undiagnosed lesions of this type. This course is further indicated for the definitive treatment of the circumscribed benign lesions.

Of 35 cases of chronic pulmonary suppurative diseases due to unexplained bronchial obstruction, 31 per cent were found to be caused by bronchogenic carcinoma. Pulmonary resection is the treatment of choice for both benign and malignant chronic pulmonary suppuration.

The risks of exploratory thoracotomy depend on the therapeutic portion of the operation. There was no mortality and minimal morbidity due to thoracic exploration per se.

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DISCUSSION

DR. OSLER ABBOTT, Atlanta, Ga.—I would like to emphasize the role of exploratory thoracotomy in diseases of the cardiovascular system, as well as that which we have heard

described in relation to the lung. At our clinic, we have been interested in the atypical character of the physical findings in a certain number of patients having patent ductus arteriosus. We recently reported a study of seven such patients. Their physical findings varied from complete absence of the diastolic component of the murmur, to patients in whom one noted absence of any murmur during certain periods of observation. We feel that in such patients considerable help may be obtained by the additional investigative procedures of angiocardiography and cardiac catheterization.

Inasmuch as one had been led to consider positive angiocardiographic findings to be almost impeccable evidence of patent ductus arteriosus, I would like to present one case in which a very typical angiocardiogram had been obtained. There was enlargement of the pulmonary artery, obliteration of the aortic window, and a saccular dilatation of the aorta in the ductus area. However, upon exploration, we found that the dilatation of the aorta was due to a combination of the aorta being sagittal in position and the aorta below the descending arch being markedly hypoplastic. Furthermore, the pulmonary artery was enlarged, due to poststenotic dilatation. The most surprising finding was a congenital absence of the left half of the pericardium. The pericardium was present on the left side, in the area of its lower third, and was constricting this area of the apex. Therefore, this was resected, and by means of keeping the patient upon the opposite side for a few days, postoperatively, an uneventful recovery occurred. The only change in physical findings following operation has been an absence of change in the character of the murmur with changes of position, which had occurred, preoperatively.

With such experiences as those noted here, there appears to be a definite place for exploratory thoracotomy in the treatment of congenital heart lesions.

# CHRONIC NONSPECIFIC SUPPURATIVE PNEUMONITIS

## A Report of Ten Cases

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With the increase of surgery for the treatment of inflammatory and malignant lesions of the lungs in the last two decades and the refinement of diagnostic procedures, our knowledge in this field continues to enlarge. This report deals with a group of patients who have been observed and treated for a nonmalignant condition of the lung to be differentiated from lung abscess, tuberculosis, bronchiogenic carcinoma, and bronchiectasis. This pulmonary lesion produces symptoms, signs, and pathologic characteristics sufficient for differentiating it as a disease entity. A definite etiological agent has not as yet been determined and the bacteriology is nonspecific.

This condition has been given the name chronic nonspecific suppurative pneumonitis and belongs under the general heading of chronic inflammatory lesions of the lung. In the literature there are a few scattered reports of similar cases, and there are doubtless many more instances which have not been published.[1, 2, 3]

### CLINICAL CHARACTERISTICS

There was a predominance of female over male patients in a ratio of about two to one. The age of the patients varied from 30 to 61 years, but most fell in the bracket between 30 and 50 years. The onset was insidious, without a recent history of an acute pneumonic process. The main symptoms were productive cough, hemoptysis, and chest pain. Many had had a productive cough for several years, coming to the doctor only when blood had appeared in the sputum. These symptoms varied in duration from three months to twenty-two years, most patients having had them for over four years. Only two patients had not experienced hemoptysis at least once and in some this was a prominent symptom. About one-half of the patients had experienced chest pain. Usually this had been present for only a few months before the patient entered the hospital. (See Table I).

Unlike patients with chronic lung abscess or bronchiectasis, this group of patients showed little evidence of weight loss and did not appear chronically ill. There was usually no evidence of sinusitis or clubbing of the fingers. The positive findings were usually confined to the chest, which revealed dullness over the involved lung areas with dry coarse râles being present in about one-half the cases.

In five patients there was a temperature elevation of 99° to 101° F. at the time of admission, and in one case this had been known to exist for more than a year. The past history and family history were noncontributory in all cases.

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Read at the Twenty-Seventh Annual Meeting of the American Association for Thoracic Surgery, St. Louis, Mo., May 28, 29, and 30, 1947.

TABLE I. CLINICAL CHARACTERISTICS IN TEN CASES OF CHRONIC NONSPECIFIC SUPPURATIVE PNEUMONITIS

| SYMPTOMS | | DURATION | | AGE | |
|---|---|---|---|---|---|
| Cough | 10 | 6 mo. | 1 | 31-40 | 5 |
| Hemoptysis | 8 | 2-4 yr. | 4 | 41-50 | 4 |
| Chest pain | 5 | 6 yr. | 2 | 51-60 | 1 |
| Temperature 99° to 101° F. | 5 | 10 yr. | 1 | | |
| | | 16 yr. | 1 | | |
| | | 22 yr. | 1 | | |

Repeated sputum examinations were negative for tubercle bacilli in every instance, and a definite etiological agent was not determined since the bacteriology was nonspecific. Blood and urine examinations were essentially normal. In three patents, there was a leucocytosis of approximately 12,000. The albumin-globulin ratio in the three cases in which it was determined varied between 0.84 and 0.94.

X-rays of the chest showed diffuse infiltration of various lung areas in all cases and a suggestion of atelectasis in four of the ten cases. In five patients, areas of infiltration in more than one lobe could be seen by x-ray. There was no identifiable abscess in any case. In seven of the ten cases, the lesions were on the right side, and in one case the lesion was bilateral. Differential diagnoses by x-ray varied with the findings but included hilar tuberculosis, lung abscess, neoplasm of the bronchus or mediastinum, pleural effusion, and bronchiectasis. Bronchograms made in some cases showed blunting of the bronchi but no evidence of dilatation.

Bronchoscopic examination revealed inflammation of the bronchial mucosa and pus formation in the bronchi of the lobes involved by the lesion in eight of the ten patients. The findings were entirely normal in one case, and a biopsy made elsewhere was reported positive for tumor in another case.

## DIFFERENTIAL DIAGNOSIS

Chronic, nonspecific, suppurative pneumonitis is to be differentiated from bronchiogenic carcinoma, benign tumors of the lung and mediastinum, lung abscess, tuberculosis, and bronchiectasis. Bronchoscopy aids in differentiating bronchiogenic carcinoma, but many carcinomatous lesions are in the periphery or in the upper lobes and cannot be visualized by bronchoscopy. In some cases, the final diagnosis must await the findings of surgical exploration and microscopic examination of the tissue.

The insidious onset and chronic course, along with the absence of an etiological factor for production of a lung abscess, are helpful in differentiating chronic nonspecific suppurative pneumonitis from either lung abscess or bronchiectasis. Furthermore, the age of these patients was considerably advanced over that which is usual for patients with bronchiectasis, and their cough was much less productive. In addition, bronchograms showed blunting of the bronchi rather than a dilatation as seen in bronchiectasis. The absence of a cavity with a fluid level in the x-rays was suggestive of pneumonitis rather than a lung abscess. The absence of tubercle bacilli in the sputum and the location of the lesion in the lower or midlung field were against the likelihood of tuberculosis but did not exclude this diagnosis.

With a realization of the existence of the condition and its characteristic findings, later cases in this series were diagnosed from the history, bronchoscopy, and x-ray findings alone. In the ten cases presented below, the preoperative diagnosis was carcinoma of the lung in three, bronchiectasis in one, tumor or infection of the mediastinum in one, and chronic, nonspecific, suppurative pneumonitis in five.

### TREATMENT

Under medical management consisting of postural drainage, bronchoscopic aspiration, bed rest, expectorants, and, in the more recent cases, the sulfa drugs, many of the patients showed a transcient period of improvement, but after variable periods of remission, symptoms would recur and a progression of the lesion could be seen by x-ray and bronchoscopy. Most of the patients became ill enough that they were forced to give up their occupations and became discouraged with the ineffectiveness of medical management.

Surgery by drainage or resection was used in nine of the ten cases presented, and was followed by complete recovery in all instances except one, that patient dying of pneumonia five days after operation. The patients became able to take part in a normal full day of activity within a year after the operation.

The earlier patients in this series of cases were treated by drainage through the chest wall. Because of the necessity of multiple operations and a longer period of morbidity by this method, subsequent patients have been treated by lobectomy or pneumonectomy as the procedure of choice. In deciding whether to treat by drainage or resection, the age and physical condition of the patient, and location of the inflammatory process were considered.

In five cases, the patients were treated by lobectomy, in two by pneumonectomy, in two by thoracotomies and open drainage. In the bilateral case, a biopsy only was made. In the five patients treated by lobectomy, the lesions were mainly in the right middle lobe in two, the left lower lobe in two, and the right lower lobe in the fifth. In two of these five cases, there was evidence of involvement of the other lobes on the same side by x-ray examination, and palpable lesions were felt in these areas at the time of surgery. In the two cases treated by pneumonectomy, the preoperative diagnosis was carcinoma of the lung, and the pathologists were unable to say definitely that biopsy sections made at the time of operation were not neoplastic. In these patients, in view of the history and x-ray findings, it was decided to completely remove the involved lung. One thoracotomy and drainage was done for a lesion in the right middle lobe, and the other was for a lesion in the right lower lobe.

All the patients except one, whether treated by resection or drainage, became symptom-free and able to partake of a full program of activity within one to two years after surgery. In the group of seven resections, there was one death occurring five days following operation. The condition of the patient with bilateral lesions was essentially unchanged when last seen. Her chest symptoms had always been minimal, her chief difficulty being arthritis. The lung pathology had been found during a routine x-ray examination.

With resection the patients' stay in the hospital averaged twenty-two days, and clearing of the remaining lung fields occurred on an average of six to seven

months. With drainage, the patients remained in the hospital an average of fifty-nine days, and clearing of the lung fields required about twelve months. Also, more inconveniences and visits to the out-patient department were required for the patients having had treatment by drainage. In the two cases treated by drainage, the patients both had a minimal bronchitis two years later and seemed more susceptible to "colds" and bronchopneumonia than the patients treated by resection. Only one of the latter group had a significant productive cough and sputum remaining one year after operation. The differential diagnosis, therapy, and results are summarized in Table II.

TABLE II. DIFFERENTIAL DIAGNOSIS AND THERAPY IN TEN CASES OF CHRONIC NONSPECIFIC SUPPURATIVE PNEUMONITIS

| PATIENT AND AGE | DIFFERENTIAL DIAGNOSIS | THERAPY | RESULTS |
|---|---|---|---|
| M. K. 47 yr. | 1. Chronic inflammation<br>2. Tuberculosis<br>3. Carcinoma | Exploratory thoracotomy with three stages of drainage | Lung fields clear except for residual pleural scar; slight productive cough |
| L. G. 32 yr. | 1. Chronic inflammation<br>2. Tumor<br>3. Hilar tuberculosis | Exploratory thoracotomy with two stages of drainage | Slight residual clouding in middle of right lung field; had minimal chronic bronchitis two years later |
| G. N. 38 yr. | 1. Tumor<br>2. Tuberculosis<br>3. Chronic pneumonitis | Biopsy | Condition essentially unchanged when last examined |
| C. W. 49 yr. | 1. Chronic inflammation<br>2. Bronchiectasis<br>3. Chronic granuloma | Right middle lobectomy | Rapid recovery with return to full activity in six months; no residual cough or sputum |
| E. S. 30 yr. | 1. Bronchial adenoma<br>2. Chronic inflammation<br>3. Inactive apical tuberculosis | Right middle lobectomy | Lung fields entirely cleared; has occasional productive cough |
| G. H. 39 yr. | 1. Chronic nontuberculosis inflammation<br>2. Abscess | Right lower lobectomy | Lung fields became clear to fluoroscopy following operation; no residual cough or sputum |
| H. M. 38 yr. | 1. Bronchiectasis<br>2. Chronic pneumonitis | Left lower lobectomy | Chest became clear by fluoroscopy; no residual cough or sputum |
| A. R. 44 yr. | 1. Chronic pneumonitis<br>2. Tuberculosis | Left lower lobectomy | Slight hemoptysis for two months postoperative; chest clear by fluoroscopy; no cough or sputum seven months after operation |
| O. S. 61 yr. | 1. Bronchiogenic carcinoma | Right pneumonectomy | Died five days after operation with hemorrhagic bronchopneumonia and pericarditis |
| A. C. 44 yr. | 1. Bronchiogenic carcinoma | Right pneumonectomy | Remaining lung field clear by fluoroscopy; no residual cough or sputum |

## PATHOLOGY

The histopathologic findings in the present series are summarized in Table III. Grossly the involved lung tissue was, in most cases, infiltrated and atelectatic. Hard nodules were palpated in the lesions in two of the cases and small necrotic areas were found on sectioning in four cases.

TABLE III. SYMPTOMS AND HISTOPATHOLOGY IN TEN CASES OF CHRONIC NONSPECIFIC SUPPURATIVE PNEUMONITIS

| CASE | COUGH | HEMOPTYSIS | DURATION IN YEARS | AGE | LOCATION OF LESION | FIBROSIS INTERLOBULAR | THICKENED FIBROSED ALVEOLAR WALLS | LYMPHOID HYPERPLASIA | BRONCHIAL LUMEN NARROWED | CHRONIC ATELECTASIS | HYALINIZATION | PLASMA CELL INFILTRATION | MACROPHAGES | SQUAMOUS EPITHELIUM | BIOPSY | RESECTION | DRAIN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 M. K. | X | X | 2 | 47 | Right lower lobe | X | X | X | — | — | — | — | X | — | X | — | X |
| 2 L. G. | X | X | ½ | 32 | Right upper middle, lower lobes | Microscopic section insufficient for pathologic study | | | | | | | | | | | |
| 3 G. N. | X | X | 16 | 38 | Bilateral in lower lobes and also right middle lobe | X | X | X | — | — | X | — | X | — | X | — | — |
| 4 C. W. | X | X | 10 | 49 | Right middle lobe | X | X | X | X | X | — | — | X | — | — | X | — |
| 5 E. S. | X | X | 6 | 30 | Right upper, middle and lower lobe | X | X | | | X | — | X | X | — | — | X | — |
| 6 G. H. | X | X | 4½ | 39 | Right lower lobe | X | X | X | X | X | — | X | X | X | — | X | — |
| 7 H. M. | X | — | 22 | 38 | Left lower lobe | X | X | XXX | XX | X | — | — | X | — | — | X | — |
| 8 A. R. | X | X | 6 | 44 | Left lower lobe | X | X | X | X | X | — | — | X | — | — | X | — |
| 9 O. S. | X | — | 3 | 61 | Right upper lobe | X | X | X | X | X | — | — | X | — | — | X | — |
| 10 A. C. | X | X | 4 | 44 | Right middle lower lobes | X | X | X | X | X | — | — | X | — | — | X | — |
| Total | 10 | 8 | | | | 9 | 9 | 9 | 7 | 7 | 1 | 2 | 10 | 1 | 3 | 7 | 2 |

TABLE IV. BACTERIOLOGICAL FINDINGS IN TEN CASES OF CHRONIC NONSPECIFIC SUPPURATIVE PNEUMONITIS

| SPUTUM AND LUNG ASPIRATION | M. K. | L. G. | G. N.* | C. W. | E. S. | G. H. | H. M. | A. R.† | O. S. | A. C. |
|---|---|---|---|---|---|---|---|---|---|---|
| Hemolytic streptococcus | + | slight + | | + | – | – | – | – | – | + |
| Nonhemolytic streptococcus | – | + | | – | + | – | – | – | – | – |
| *Strep. viridans* | – | + | | + | + | + | + | – | + | + |
| *Staph. albus* | + | – | | – | + | – | – | – | + | – |
| Hemolytic *Staph. albus* | + | – | | – | – | – | – | – | – | – |
| *Staph. aureus* | – | – | | – | – | + | – | – | – | – |
| *Staph. aureus* hemolytic | + | – | | – | – | – | – | – | – | – |
| Nonhemolytic staphylococcus | – | – | | – | + | – | – | – | – | – |
| *N. catarrhalis* | – | – | | + | – | – | – | – | + | + |
| Diphtheroids | + | + | | + | – | – | – | – | – | – |
| Small gram (–) rods | + | – | | + | – | – | + | – | + | – |
| Acid-fast | – (guinea pig) | – | – | – | – | – | – | – | – | – (guinea pig) |
| *B. coli* | – | + | | – | – | – | – | – | – | – |
| Pneumococcus | – | + | | – | – | – | – | – | – | – |
| Fusiform bacilli | – | + | | – | – | – | – | – | – | – |
| Spra<br>Typhoid<br>Paratyphoid<br>Brucella<br>Agglutinations | – | – | – | – | – | – | Blood Wassermann positive | – | – | – |
| Friedländer bacillus | – | – | | – | – | – | + | – | – | – |
| Fungus | 0‡ | – sab | | 0 | – sab | – sab | 0 | 0 | – sab | 0 |

*No anaerobic or aerobic growth from biopsy. Direct smear showed (+) cocci and rods and gram-negative organisms. Guinea pig negative for TBC and fungus from tissue culture negative.

†Mostly hemorrhage.

‡0 Indicates cultures were not made.

In general, the histologic picture showed extensive interlobular fibrosis and also fibrosis and thickening of the alveolar walls. There was considerable lymphoid and plasma cell hyperplasia, and the bronchial lumina were somewhat narrowed by the redundant mucosa. Chronic atelectasis was present, blood being found in the alveoli. Many blood vessels presented markedly thickened walls. Hyalinization was present in only one case and squamous metaplasia of the bronchi in only one instance. Some alveoli were lined by bronchiolar epithelium. No bronchial dilatation, acute inflammation, or evidence of walling off as in an abscess were seen. The histopathologic diagnosis was chronic diffuse pneumonitis. This frequently is the only means of differentiating this lesion from bronchiectasis, tumor, and lung abscess.

Aerobic and anaerobic cultures of pus obtained from the bronchi by bronchoscopy and from the tissue removed at the time of surgery showed a nonspecific type of bacteriology. Cultures made for fungus were also negative. Agglutinations for brucella, typhoid, and paratyphoid were also within the normal range in the four patients examined. No virus studies were made. The bacteriologic findings are summarized in Table IV.

Two of the ten cases are being reported in detail to bring out most of the clinicopathologic characteristics and to describe the two methods of management.

CASE 1.—A 44-year-old white man, A. C., came to the clinic with the complaints of hemoptysis for four days, foul sputum averaging about one cup a day for four months, cough of four years' duration, and a weight loss of thirty pounds during the preceding four months.

The patient stated that four months previously he had a sudden onset of weakness one morning accompanied by a cough with the production of foul-smelling sputum and a fever of 103° F., nausea and vomiting, and pain in the chest on coughing. He was treated for lung abscess by his physician and was forced to give up his job as a crane operator. X-rays taken at that time were said to be suggestive of lung abscess. During this period he had a weight loss of 40 pounds. After six weeks, he was able to return to work, had gained ten pounds but still continued to cough and produce a foul-smelling sputum and had a slight elevation of his temperature. Four days before coming here, his sputum began to be tinged with both old and fresh blood and occasionally clots were seen.

He said that he had no severe upper respiratory infection since two years ago when he was treated for pleurisy. He stated that he had pneumonia when 24 years of age. There was no history of tuberculosis in the family.

Physical examination revealed a well-developed and well-nourished man who did not appear acutely ill. The positive physical findings were limited entirely to the chest. There was dullness to percussion over the chest down to the fourth interspace, both anteriorly and posteriorly. Tactile and vocal fremitus were both reduced over this area. A few course râles were heard over the right upper chest. The remainder of the chest was normal. The cardiac dullness and and heart tones were within normal limits. There was minimal clubbing of the fingers, and the gingiva were coated and inflamed.

The laboratory findings demonstrated a normal red cell count and hemoglobin. The white cell count was about 5,000. X-ray and fluoroscopic examination of the chest showed a well-demarcated, infiltrative lesion occupying the middle third of the right lung. There was no evidence of encapsulation or a fluid level. Bronchoscopy showed an inflamed bronchial epithelium on the right side and obliteration of the right upper lobe bronchus by gross swelling of the mucosa. Thick, foul pus rolled out of the right upper bronchus with coughing. The sputum was negative for tubercle bacilli.

The diagnosis, made on the basis of x-ray, fluoroscopic, and bronchoscopic findings, in addition to the history of rather an acute onset of most of the symptoms, was carcinoma of the lung with large lymph nodes below the carina. (See Fig. 1, *A*.)

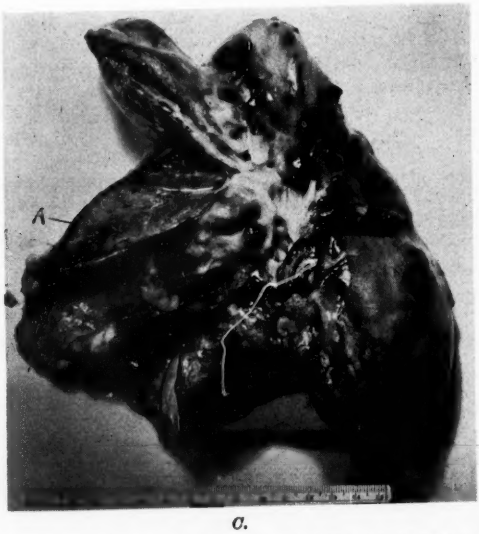
The patient was advised to have a right pneumonectomy. The blood picture and plasma protein level of 7.77 being within normal limits, on admission, there was little preparation needed for operation.

*Operation.*—The operation was performed under ethylene plus ether plus oxygen. Intravenous saline, 1,000 c.c. and 1,200 c.c. of blood were given during the operation. On Nov. 16, 1944, a right pneumonectomy was done, an incision being made over the sixth rib area. The lung was markedly adherent to the chest wall throughout, sharp dissection being necessary to free it. After the lung was freed, a large hardened area was felt in the region of the bronchus approximately 3 cm. by 2 cm. The phrenic nerve was crushed and the pulmonary artery and veins isolated. There was a small node in the mediastinum which was removed and the pathologists could not say definitely whether this showed hyperplasia or neoplastic tissue. Two hard nodes were also palpated below the carina and were removed, thus exposing the left bronchus. A hard node superior to the carina was also removed. After removal of the lung, and before closing the wound, 500 c.c. of plasma and 200,000 units of penicillin were placed in the pleural space.

*Surgical Pathology.*—The specimen consisted of the entire right lung. The pleural surface over all the lobes was grossly thickened. There was a small hard nodule 0.5 cm. in diameter in the anterior aspect of the lower lobe, which was otherwise normal in consistency. The upper portion of the middle lobe was hard and diffusely infiltrated. The upper lobe was firm and dense in consistency and on section a small cavity was found in the apex communicating directly with the main bronchus of the lobe. The cavity and bronchus contained purulent exudate. The hilar nodes were enlarged and firm in consistency.

Microscopic sections showed interlobular fibrosis and considerable thickening of the alveolar walls. There was more exudate than blood in the alveoli, which also contained many macrophages. In some areas the thickened alveolar walls were lined with bronchiolar epithelium. Lymphoid hyperplasia was extensive and squamous metaplasia of the bronchial epithelium was present in some areas. The bronchial lumina were somewhat decreased in size by the muscularis mucosa being in folds due to lymphoid and plasma cell hyperplasia.

*A.* *B.*




*C.*

Fig. 1.—*A*, A. C. X-ray of chest showing an ill-defined infiltrating lesion occupying the upper two-thirds of the right lung. X-ray diagnosis, bronchiogenic carcinoma. *B*, X-ray of chest following total right pneumonectomy. The right pleural cavity has been completely filled with fluid. *C*, Photograph of right lung showing upper lobe sectioned. This revealed diffuse infiltration with a small area of liquefaction seen at *A*. There was no evidence of abscess formation.

*Bacteriology.*—Cultures showed *Streptococcus viridans, Neisseria catarrhalis* and hemolytic streptococci. Guinea pig inoculations were negative for tuberculosis.

*Postoperative Course.*—There were no respiratory difficulties or other complications, and the patient was discharged from the hospital three weeks after the operation. The patient's convalescence was uneventful, the temperature remaining below 100° F., except on two occasions when it reached 101° F. When seen about six months after the operation, fluoroscopy of the chest showed the left lung field to be clear, and except at periods during occasional colds, the patient was free from cough and sputum. He began working full time about a year after the operation.

During the next year and one-half, the patient was well except for a mild unproductive cough. Following this period, he became feverish and began to feel weak. Five days later, he noticed a progressive enlargement in the right chest wall which became hyperemic and tender. Ten days after the onset of symptoms, he was seen in the out-patient department and admitted to the hospital.

Physical examination was essentially normal except for the chest. The right side of the chest was dull to percussion and distant bronchial breathing was heard on auscultation. In the anterior axillary line about three fingerbreadths below the axilla there was a large hemispheric tumor about 19 cm. across. The lowermost portion of this mass was tender and slightly fluctuant.

The urine and blood examinations were normal, the leucocyte count being 10,950. The diagnosis was empyema necessitatus. X-rays of the chest at this time showed only the postoperative appearance of a pneumonectomy on the right side and a normal lung on the left side. On July 12, 1946, the abscess was incised and about a liter of foul-smelling yellowish pus was removed. Exploration of the wound revealed a fistulous tract entering the chest cavity through the third interspace. Drains were placed in the chest and in the subcutaneous abscess. After a short period of convalescence the pleural space was obliterated by a two-stage thoracoplasty. The patient made a satisfactory recovery and has returned to full-time employment.

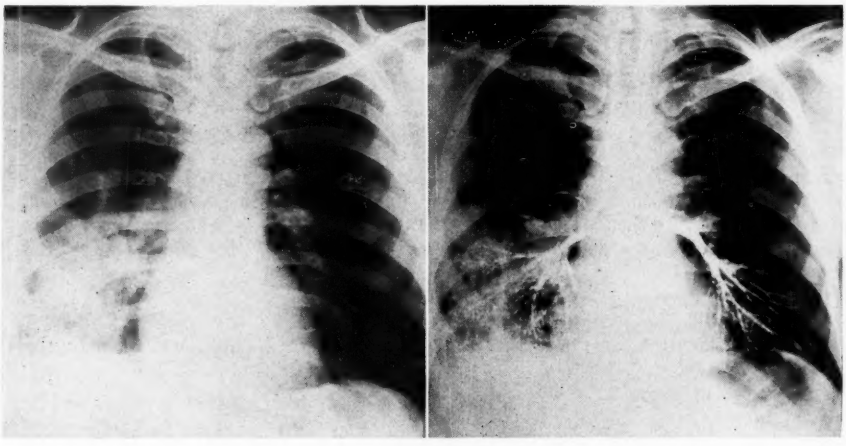
*Comment.*—This patient illustrates the difficulty of differentiating chronic, nonspecific, suppurative pneumonitis from bronchiogenic carcinoma. The rather acute exacerbation of the symptoms combined with the physical and x-ray findings led to the preoperative diagnosis of tumor, although nothing could be seen or found by bronchoscopy and biopsy. The final diagnosis had to await microscopic examination which showed a rather typical histologic picture of the disease being discussed.

CASE 2.—A 47-year-old truck driver, M. K., was first seen at the clinic with complaints of a productive cough and weakness for two years, a 25-pound weight loss and occasional night sweats for two months. The patient said that he "caught cold" about a year previously and following this had a productive cough and weakness and had lost weight. Following this illness, he was apparently fairly well until about four months previously when he had another illness similar to the one above, but this time the cough and sputum persisted. Two months previously he had been confined to bed for two weeks with what his physician termed a "mild case of pneumonia." There was no hemoptysis. At this time, he began to have night sweats. The sputum had become foul smelling in the past two months and had increased to a cupful a day. He had not worked for five months. The remainder of the history was noncontributory.

Physical examination revealed a well-developed, fairly well-nourished man who did not appear acutely ill but had occasional episodes of coughing. The positive findings were limited entirely to the chest. The left side of the chest and left lung were normal. On the right side there was definite limitation of movement of the diaphragm and dullness to percussion below the sixth thoracic interspace posteriorly, extending around to about the anterior axillary line. Fine crepitant râles were heard over the area on inspiration.

Tactile and vocal fremitus were equal on both sides and there was diminution of breath sounds over the area of dullness. The cardiac dullness and heart tones were within normal limits.

The patient was admitted immediately to the hospital on the medical service for further study. Laboratory findings at that time demonstrated a normal red cell count and hemoglobin with a white count of 9,300. The urine was normal. X-ray examination of the chest at that time revealed a slight elevation of the right leaf of the diaphragm and filling of the costophrenic angle on this side. The left lung was normal. The upper half of the right lung was clear; the lower half was involved by definite infiltrative lesions which extended from the lower portion of the hilum, especially in the area of the seventh rib posteriorly, downward and laterally in the area of the eighth and ninth ribs. A portion of the right lower lobe appeared atelectatic. No abscess cavity was seen. Bronchograms showed narrowing at the bifurcation of the bronchus to the lower lobe. (See Fig. 2, *A* and *B*.) There was no evidence of bronchial dilatation. Bronchoscopy was normal except in the area of the right lower lobe where the bronchial mucosa of that lobe was thickened and



*A.* *B.*

Fig. 2, *A* and *B*.—*A*, M. K. X-ray of chest showing a poorly defined infiltrating lesion occupying the lower third of the right chest. *B*, X-ray showing iodized oil injection of the lower lobes. Note poor filling in right lower lobe region with blunting of secondary bronchi. There is no evidence of bronchiectasis or lung abscess.

injected and contained a small amount of blood-tinged sputum. Just above the point of division, the main bronchial lumen was distinctly narrowed but was still circular in shape. No granulations or tumor masses were seen. The diagnosis of chronic inflammation or bronchiogenic carcinoma was entertained at this time on the basis of x-ray and bronchoscopic findings. A biopsy of the inflamed bronchial mucosa made a week later revealed only a mild degree of inflammatory reaction but no tumor cells or ulceration. No definite diagnosis was made, and the patient was discharged from the hospital four days after admission to be followed in the out-patient department.

He again entered the hospital five months later. During the intervening period, he had been fluoroscoped and had a second x-ray examination which showed the lung lesion to be essentially unchanged. During the interim, the patient had gained a little weight, and said that his cough had become less severe. He had been able to return to work. About one month before the second admission, he began to raise more sputum and enlargement of the lesions in the lung was noted on fluoroscopy. He again began to lose weight. Bronchoscopy showed an increase in the inflammation of the bronchial mucosa, but biopsy again revealed

no evidence of malignancy. Due to the negative bronchoscopic findings and the chronic course, it was felt that the patient had a chronic, slowly progressing pulmonary suppurative disease and he was again admitted to the hospital. At the time of the second admission, he was coughing almost continuously and appeared somewhat emaciated.

Physical findings at this time were essentially the same as before. The sputum was seen to contain blood. Laboratory findings showed a normal urine, red cell count, and hemoglobin. The white cell count was 13,000.

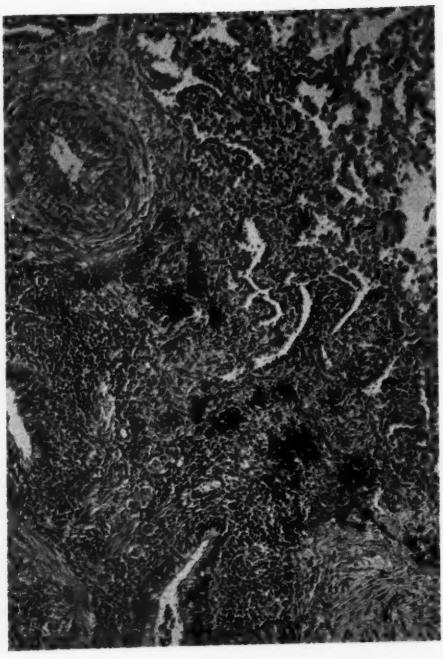
X-ray examination revealed the lesions to be essentially unchanged. Sinus x-rays taken at this time were normal. Bronchoscopy showed large quantities of pus coming from the right bronchi with a red and thickened mucosa, and some constriction of the secondary bronchi was seen.

In view of the consistently negative findings for tumor and the long chronic course and sputum examinations negative for tubercle bacilli, a diagnosis of chronic pulmonary suppuration was made. Postural drainage and potassium iodide were ineffective and the patient was prepared for surgery.

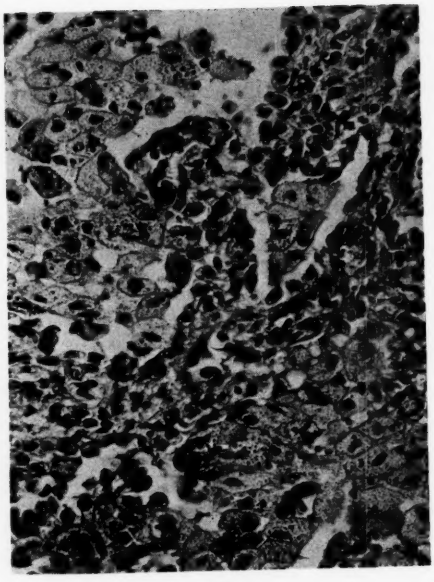
Fig. 2*C*.—M. K. Low-power microscopic section of tissue removed from lower lobe showing marked interlobular fibrosis and lymphoid hyperplasia.

*Operation.*—A two-stage drainage under ethylene-oxygen anesthesia was planned, the first stage being done on Feb. 21, 1939. An incision was mad through the eighth rib area. Dense, vascular adhesions were encountered and were dissected superiorly to about the level of the sixth interspace. The lung was everywhere bound by similar pleural adhesions. On palpation, the lung was firm, somewhat irregular in consistency, and apparently apneumatic. Because of the vascular adhesions and indurated consistency of the lung tissue, further operative procedure was considered inadvisable. An area in the posterior axillary line was packed with gauze and the wound was closed.

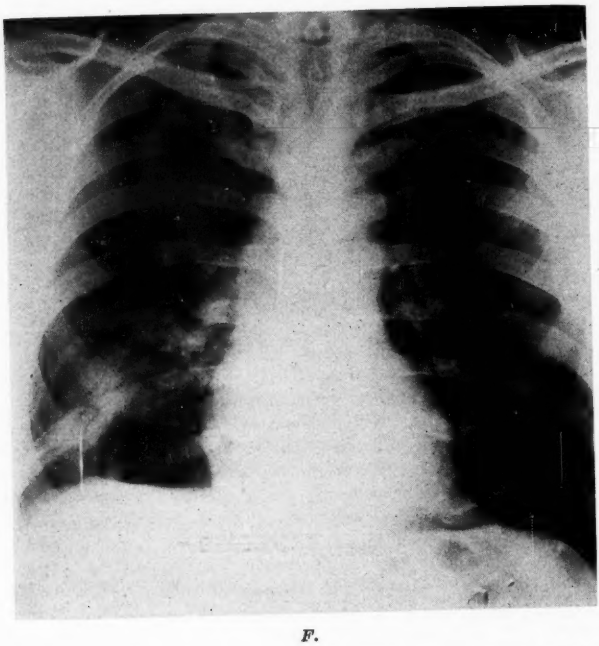
Three days later the second stage was done under local anesthesia. The middle of the previous wound was reopened and the packs removed. An aspirating needle was introduced into the region suggested by the x-rays as being involved, but no frank pus was obtained. The lung was then divided by cautery, a piece 1.5 by 1 cm. being removed for microscopic study. The lung was then explored by an aspirating needle in the depths of this area. Actual



*D.*



*E.*



*F.*

Fig. 2, *D*, *E*, and *F*.—*D* and *E*, M. K. High power photomicrographs of the lung showing thickened, fibrosed alveolar walls, plasma cell infiltration, thickening of blood vessel walls, and many fat-filled macrophages. *F*, X-ray of chest showing complete healing of lesion in right lower lobe. Only mild fibrosis and some tenting adhesions at midportion of the diaphragm remained.

cautery was then used to expose the area for drainage. The tissues in this region were friable and the septae were broken with the finger tip. Little egress or ingress of air was noted. No frank pus was found. The tissues were curetted for microscopic section, and the entire space was packed open with a petrolatum gauze roll.

Postoperatively, there was profuse serous drainage from the wound. Three weeks later, the wound was enlarged under local anesthesia. With the Bovie coagulation, the incision in the lung tissue was extended superiorly and medially. A definite abscess cavity was not encountered. There was a moderate amount of pus and necrotic material in this area. A block of lung tissue measuring about 3 by 2 by 2 cm. was removed for microscopic study. No evidence of saeculation was demonstrable and no tissue resembling tumor was encountered. The wound was packed open. There was no gross evidence of bronchial fistulae.

*Surgical Pathology.*—The microscopic sections of lung tissue showed interlobular fibrosis and thickened alveolar walls with lymphoid hyperplasia and some chronic interstitial inflammation.

*Bacteriology.*—Diphtheroids, small gram-negative rods, hemolytic streptococci, *Staphylococcus albus,* hemolytic *Staph. albus* and *aureus* were found in the cultures. Guinea pig innoculations were negative for tuberculosis.

*Postoperative Course.*—The patient had a very uneventful convalescence, the temperature being over 100° F. on only one occasion following the third stage. Drainage from the wound was profuse at first, but by the time of the patient's discharge, a small tube was being used and drainage was minimal. The patient was discharged two and one-half weeks after the operation and returned to the out-clinic for change of dressings. X-rays taken two months after the final operation showed a decrease in the size of the density in the right lower lung. The wound was completely healed six months after surgery and x-rays at that time showed only mild fibrosis remaining in the middle of the right lower lung field and tenting adhesions at the midportion of the right leaf of the diaphragm. (Fig. 2, *F.*) The patient returned to work about this time and had only a slight productive cough upon arising in the morning, the temperature being normal. He has been seen at infrequent intervals and has remained well.

*Comment.*—The difficulty in differentiating this lesion from bronchiogenic carcinoma and lung abscess is shown. The final diagnosis was not made until the lung was explored and the surgical specimen examined.

The greater chance for complications and the slower rate of recovery, and correspondingly longer period of hospitalization with treatment by drainage, indicate the advantage of lobectomy and pneumonectomy.

## DISCUSSION

In recent years, there has been little written on inflammatory lung conditions per se and most of the articles before 1940 appeared under the heading of chronic nontuberculous pulmonary disease.

Solomon[4] in 1940 reported seventeen cases of chronic infection of the lungs due to the Friedländer bacillus. Most of these cases showed complete clearing of the lung fields eventually, but a few showed some residual fibrosis. Bronchiectasis and abscesses may also develop from this condition. The cases presented by Solomon all had an acute phase just preceding the chronic phase.

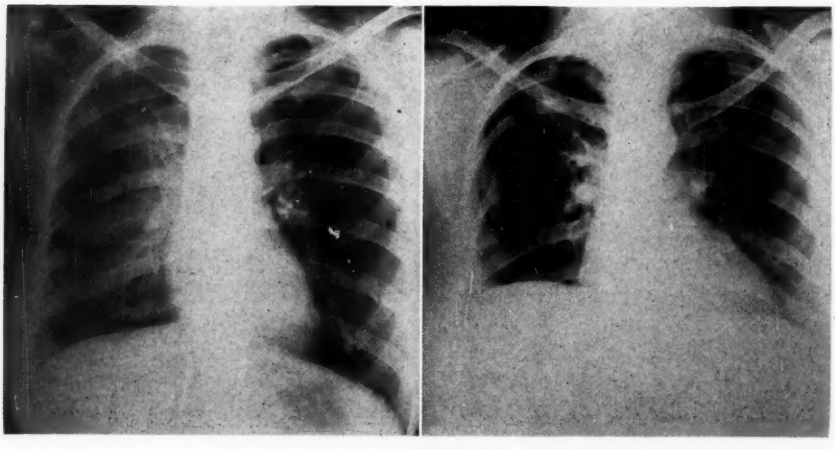
The group of cases being reported differ from the above in that there is no acute onset, the patient having had cough and sputum for months or years and gradually being overcome by the lung condition. Also, the lesions tend to progress, and there is no definite etiological factor known, as in Solomon's group.

Friedländer and Wolpaw,[1] in an article on the differentiation of bronchiogenic carcinoma from chronic inflammatory lesions of the lung, present four

*A.* *B.*

Fig. 3.—*A*, C. W. X-ray of chest of a 49-year-old white woman who complained of a productive cough with repeated hemoptyses of ten years' duration. There had been mild pain in the right lower thorax for the preceding few months. Note ill-defined diffuse density at cardiophrenic angle.

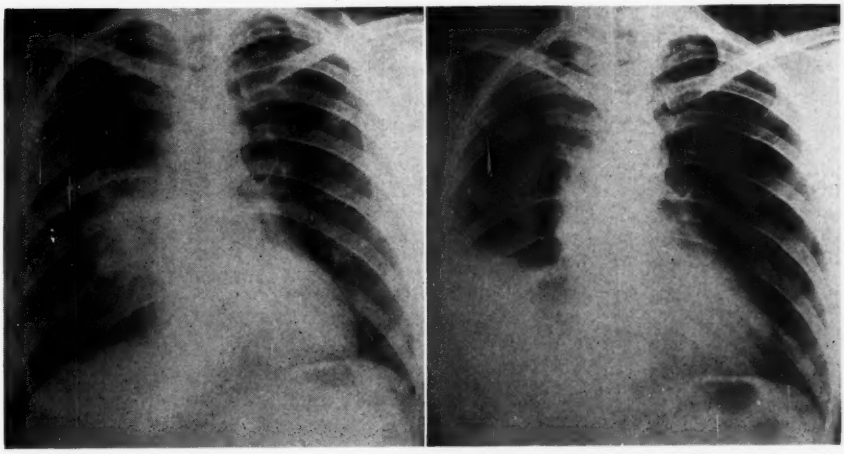
*B*, X-ray of chest following iodized oil injection. Note poor filling of right lower lobe with some blunting of secondary bronchi. The right lower lobe was resected, after which the patient was completely relieved of symptoms. The specimen removed showed diffuse infiltration of the lung without evidence of abscess or bronchiectasis. Microscopic sections revealed a picture similar to that described in Fig. 2.



*A.* *B.*

Fig. 4.—*A*, L. G. X-ray of chest of a 32-year-old white woman who complained of a productive cough and hemoptysis of six months' duration. Note diffuse infiltration of right lung extending out from the hilum. Bronchoscopy revealed pus coming from the entire right lung. Exploration showed diffuse infiltrating lesion involving all three lobes. By multiple stages this was drained which resulted in complete relief of symptoms.

*B*, X-ray of chest showing clearing of the lung following drainage. Microscopic sections revealed pathologic changes similar to those described in Fig. 2.



*A.* *B.*

Fig. 5.—*A*, G. H. X-ray of chest of a 39-year-old white woman who complained of a productive cough and hemoptysis of four and one-half years' duration. Bronchoscopy revealed pus coming from the right lower lobe. *B*, X-ray of chest following resection of the right lower lobe. The lesion consisted of a diffuse infiltration of the upper half of the right lower lobe without evidence of abscess or bronchiectasis. Operation was followed by complete relief of symptoms.

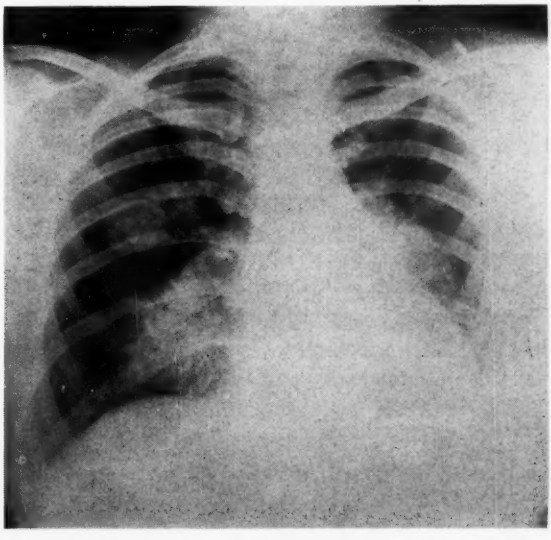


Fig. 6.—G. N. X-ray of chest of a 38-year-old white woman who had symptoms of a mildly productive cough with repeated hemoptysis of sixteen years' duration. Her chief complaint had been multiple arthritis of the knees, ankles, and wrists. Note bilateral infiltrations involving upper and lower lobes. Bronchoscopy and other diagnostic procedures aided little in making the diagnosis. Thoracotomy and biopsy of the lesion in the mid-right lung field showed only diffuse nontuberculous infiltration of the lung with a microscopic picture similar to that described in Fig. 2. The patient's condition remained unchanged when last seen approximately a year following the biopsy.

cases of patients operated for tumors which, histologically, proved to be chronic inflammatory lesions. One of these cases was similar to the ten cases presented below and the inflammation was described as nonspecific in character. No diagnostic method, except awareness of the possibility, was suggested to distinguish the two conditions.

The condition of bronchiectasis is thought by several authorities to develop from suppurative lesions following an acute attack of pneumonia. Hamman,[5] writing concerning nontuberculous basal infections of the lungs, which he thinks are cases of bronchiectasis, gives as characteristic of these cases: (1) cough and expectoration coming on insidiously as a cold or upper respiratory infection; (2) symptoms which persist indefinitely; (3) a moderate, irregular fever; (4) no weight loss, weakness, or exhaustion; (5) usually occurring between the ages of 20 and 40 years; and (6) frequent hemoptysis. X-rays showed only increased pulmonary markings but no definite evidence of pulmonary infiltration, and in all cases the lesions were confined to the lower lobes. One autopsy showed dilatation of the bronchi, and the author assumed this to be present in all the other cases.

The present group differs from Hamman's description of bronchiectasis in the occurrence of weight loss and weakness in addition to a slightly older age group, the earliest age in the cases of this report being 30 years. Also, there is definite evidence of pulmonary infiltration in every instance, and the lesions are not confined to the lower lobes.

According to Sussman[6, 7] "nonputrid pulmonary suppuration differs from simple pneumonia by the occurrence of necrosis of the pulmonary parenchyma." Scadding,[2] writing on "chronic pneumonias," describes most of the cases as resulting from a delayed resolution of an acute pneumonia, or with less acute onset, but with symptoms having been present only a few weeks prior to admission to the hospital. All cases presented were treated without surgery. He defines chronic pneumonias as "a chronic inflammation in which exudation into the pulmonary alveoli is the primary process with organization leading to fibrosis, and suppuration leading to abscess formation, as possible secondary processes, resolution being possible at any stage with more or less residual fibrosis."

The disease entity described in this paper differs from Scadding's chronic pneumonias in, again, the absence of an acute phase, the much longer course, the lack of resolution without surgical treatment, and the lack of progression to abscess formation as a secondary process.

Graham, Singer, and Ballon[8] in their text on surgical diseases of the chest, state that the symptoms of chronic lung abscess may be quite varied and may include cough, blood-stained sputum, fever, chills, sweats, chest pain, weakness, and loss of appetite, in order of frequency. The patients often have a history of repeated respiratory infection. Pathologically, they described lung abscess as "consisting of an irregularly shaped cavity containing thick pus which is often blood-stained. The floor of the cavity is lined with necrotic tissue. Sur-

rounding the abscess is a thick zone of dense fibrous tissue with prolongations of fibrous tissue extending out into the lung in various directions.'' Some degree of bronchiectasis is stated to be almost always present. A fluid level is necessary for diagnosis by x-ray, other roentgen findings being only suggestive.

In chronic nonspecific pneumonitis the symptoms are chronic and may be quite similar to those of a lung abscess. However, a cavity with a fluid level was not demonstrable on x-ray and the microscopic pathology was unlike that of lung abscess. Bronchiectatic dilatations were absent.

From the standpoint of treatment, the most important conditions to differentiate are bronchiogenic carcinoma and pulmonary tuberculosis. In the case of the former, pneumonectomy is usually the operation of choice whereas a lobectomy may be sufficient in the condition under discussion. In pulmonary tuberculosis, although resection of the lung is indicated in some cases, collapse therapy is more frequently the treatment of choice.

## SUMMARY AND CONCLUSION

Ten cases of chronic nontuberculosis inflammation of the lung are reported which present a clinical entity unlike that of lung abscess and bronchiectasis. This disease process is characterized by an insidious onset, chronic course, productive cough and hemoptysis, and a diffuse chronic inflammation of the lung without abscess formation. It must be differentiated from bronchiogenic carcinoma, chronic lung abscess, tuberculosis, and bronchiectasis. The principal features of differential diagnosis are a gradual onset of symptoms without obvious cause, and diffuse infiltration of the lung without bronchial dilatation or cavity formation on x-ray examination. Differentiation of bronchiogenic carcinoma from this lesion in the cases of short duration usually must await pathologic study.

In the ten patients reported, the lesion was resected in seven, drained in two, and biopsied in one. Of the nine patients treated, eight were relieved of symptoms. One patient died five days after resection of the lesion, of bronchial pneumonia of the other lung. Resection of the inflammatory lesion is preferred to drainage, since the period of morbidity is much shorter with the former treatment, and relief of symptoms is likely to be more complete. When bronchiogenic carcinoma cannot be ruled out, this is a further indication for resection of the lesion.

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DISCUSSION

DR. ROBERT M. JANES, Toronto, Ont.—I have been much interested in Dr. Adams' presentation. I am sorry that I did not read the synopsis before coming here, because the cases are very similar, I think, to two that I have operated upon in the last year.

In 1925, Lachlin, in Toronto, working as a relief pathologist at the Children's Hospital, encountered three unusual cases of chronic bronchopneumonia from which children died. The pathologic examination demonstrated that these lungs contained a large amount of fat. Subsequent experimental work showed that this picture could be reproduced by instillation of paraffin oil into rabbits' lungs.

There has been a good deal in the medical and pathologic literature since that time, but surgeons, I think, have perhaps lost sight of it. I know I did, and it seems to me that this is the disease that Dr. Adams has presented to us. At any rate, some of the cases that he has shown seem to be cases of chronic lipoid pneumonia. They go through various stages, from the acute, subacute—in which many of them formerly died of a bronchial pneumonia, although fewer of them are likely to do so now, with the antibiotics—and finally end up with dense fibrosis which is likely to be mistaken for bronchiogenic carcinoma.

The disease is peculiar in that apparently it is possible to have instilled large amounts of oil without the development of lipoid pneumonia. Indeed, it must be because of the frequency with which this has been used, and yet relatively small amounts, it would appear, are capable of producing the disease.

DR. H. BRODIE STEPHENS, San Francisco, Calif.—Dr. Adams is to be congratulated for grouping a type of pulmonary inflammation that all of us have seen but have made no attempt to bring under one clinical classification.

I performed multiple lobectomy recently on the right lung of a patient whose history was much the same as Dr. Janes' patient. The gross and microscopic picture of the original specimen from my patient's lung was similar to those Dr. Adams has demonstrated. We did our best to bring out the history of oil aspiration in this patient but we had to conclude our patient had not used petroleum oil in any form. The patients presented by Dr. Adams certainly resemble cases of lipoid pneumonia and I believe we should continue to make every attempt to prove the diagnosis of lipoid pneumonia before accepting the diagnosis of "chronic nonspecific suppurative pneumonitis."

DR. RALPH B. BETTMAN, Chicago, Ill.—In the first place, I think we should all thank Dr. Adams for giving us a nice new category or pigeonhole in which to place many of the cases that we have all seen and that have been bothering us because we did not know where to put them.

I want to report simply one case to bring out something from the diagnostic and therapeutic point of view.

About four years ago we had a patient at Michael Reese who I am sure, now, would have fallen into this category. The x-ray pictures were so suggestive of a carcinoma of the lung that we decided to go ahead and do a pneumonectomy. However, the patient happened to be a very close relative of the head of our tumor group, and the doctor asked whether we thought it would do any harm if he gave her a course of x-ray treatment first.

We thought the delay would not be very important, inasmuch as the patient had symptoms for a long while. To our great surprise, following the x-ray treatment, the symptoms relieved themselves within two or three days, and the lesion, as far as the x-ray manifestation thereof was concerned, completely melted away in a matter of weeks, and now, four years later, the patient is absolutely well. I think that perhaps the explanation of the efficacious effect of the x-ray treatment can be along the line that Dr. Adams pointed out, when he called attention to the large amount of lymphoid hyperplasia in all these cases.

DR. RICHARD H. MEADE, JR., Chicago, Ill.—I should like to add just three other cases similar to Dr. Adams'.

The first two were chronic in nature. The third patient was operated on the morning after Dr. Adams had talked on this subject in Chicago. This patient had a short history. There was x-ray evidence of atelectasis of the right upper lobe, and although the bronchoscopic examination was negative, we were quite sure that there was a bronchial obstruction due to carcinoma. It has become our habit to look upon such cases almost invariably as carcinoma.

This man had been sick only for two months. He had a history suggesting pneumonia, with some subsidence of symptoms and signs under penicillin therapy.

At operation the upper lobe was found imbedded in the chest by very dense adhesions. When we discovered there was no evidence of tumor, in view of Dr. Adams' paper the night before, we proceeded to do an upper lobe lobectomy. The study of that lobe showed chronic interstitial pneumonitis.

I would think this fitted in well with the group of Dr. Adams' cases, but it was one of very short duration, and I think that gives evidence that this pneumonitic process can develop in a very short period of time.

DR. W. E. ADAMS, Chicago, Ill.—Regarding the question of this being lipoid pneumonia, I do not believe we can say definitely. As Dr. Janes has pointed out, it does not take very much oil to produce that picture. But the microscopic appearance was not like that produced in lipoid pneumonia.

In these cases there was no history of having used oil in the nose, or treatment of upper respiratory infections, but many of the patients had this over such a long period of time that they may not have recalled sufficiently.

Dr. Bettman's question of x-ray therapy is a good one, I think. If this condition is seen early, it might possibly respond to x-ray therapy. Some of our cases were treated by x-ray, but they had had the condition so long that I believe the fibrosis prevented its being effective.

Likewise, I think chemotherapy should be used as a routine, but if response is not immediate, surgery is indicated.

I want to leave this last remark with you, that I feel very strongly that all these cases should be resected, first because so often they cannot be differentiated from bronchiogenic carcinoma. Also, if, at the time of operation, there seems to be a reasonable chance that it is inflammatory rather than malignant, a lobectomy in cases of the older age group might be sufficient, and be the wiser operation to do.

# PULMONARY RESECTION FOR CHRONIC ABSCESS OF THE LUNG

ROBERT R. SHAW, M.D., AND DONALD L. PAULSON, M.D. (BY INVITATION)
DALLAS, TEXAS

ABSCESS of the lung has constituted one of the most vexing problems of the thoracic surgeon. Whereas it has long since been proved that medical treatment is ineffective and that this disease is best treated surgically, the ultimate results have not been completely satisfactory. The advent of one-stage surgical drainage, as advocated by Neuhof, represented a definite advance and increased the percentage of satisfactory results of surgical treatment. The increasing safety of pulmonary resection has led to a more frequent application of this procedure in the surgical management of putrid abscess of the lung and has made possible the salvage of a still greater percentage of patients.

Based on statistics available in the literature, it may be stated that the mortality of the disease of putrid abscess of the lung ranges from 30 to 40 per cent. In addition to this high mortality the disease carries a high morbidity. The clinical course is characterized in the chronic phase of the disease by intermittent remissions and exacerbations. During a period of quiescence, the patient continues to cough and expectorate foul sputum, but has very little fever and may be able to carry out his usual activities to a limited degree. During periods of exacerbation of the disease, the patient has high fever, cough with the expectoration of large amounts of foul sputum, and loss of weight. Severe or fatal hemoptysis may occur. Metastatic abscesses to other organs, notably the brain, may develop at any time.

An acute lung abscess is usually unilocular. A chronic abscess of the lung, on the other hand, may become multilocular or be composed of multiple cavities. Bronchiectatic changes in the communicating bronchi frequently occur. Multiple abscesses a few millimeters to a centimeter in diameter may occur as part of a localized chronic pneumonitis occupying a portion of one lobe. The whole lung may be honeycombed by multiple or more or less communicating larger abscesses. The surrounding fibrosis varies greatly in amount and extent. It may simply surround the smaller abscesses, the remaining lung appearing normal. The other extreme is for the entire lung to become fibrotic. The walls of the chronic abscesses are frequently ulcerated and often bleed easily. A rapidly progressive gangrene may develop on the basis of a chronic abscess. Occasionally the walls of a chronic abscess may become completely lined by the proliferation of epithelium from the communicating bronchi. Such an abscess and the communicating dilated bronchi continue to harbor the infection indefinitely.

It becomes apparent from this consideration of the pathology of a chronic putrid abscess in the lung that, in the surgical treatment, drainage alone cannot result in a high percentage of cures. The present report is concerned with the

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results of the surgical treatment in eighty-six unselected patients having chronic putrid abscess of the lung. As a basis for comparison of the results obtained in this series, we have used the report made by one of us* in 1941 concerning the surgical treatment of putrid abscess of the lung in thirty-three patients. In the former report, surgical drainage was done in all instances. Two patients eventually had pulmonary resection after having been subjected to drainage previously. Nineteen patients, or 57.6 per cent, were considered well following surgical treatment. The mortality was 15.2 per cent.

## THE PRESENT SERIES

The present series of cases consists of eighty-six unselected patients treated surgically by us during a three-year period from 1944 to 1947. Six additional patients were seen during this period in whom a putrid abscess of the lung resolved without surgical treatment. All abscesses of a nonputrid type have been excluded from this study.

Ninety-nine surgical procedures were carried out in eighty-six patients. Because the drainage of a putrid abscess of the lung and the drainage of a putrid empyema with a lung abscess represent different problems, these cases were considered separately. Likewise, pulmonary resection for an active abscess presents a different problem from a pulmonary resection for the residual of an abscess, and accordingly these groups were studied separately.

The indications for drainage of an abscess of the lung consisted of an abscess of short duration which was thought to contain a solitary nonepithelialized cavity. In a second group of patients, drainage of the abscess was done as a matter of expediency with the plan in mind of doing a subsequent pulmonary resection. The patients in this group were considered either too acutely ill or in too poor general condition to withstand a primary resection, or it was believed that the extent of the abscess could be diminished by drainage, thereby decreasing the amount of lung tissue to be resection at a subsequent date. The duration of the abscesses in this group varied from one month to twenty-four months, the average being four and one-half months. The ages of these patients ranged from 14 months to 54 years.

Drainage of the abscesses of the lung was done by resection of small segments of one or two ribs as a one-stage procedure in almost all cases. A satisfactory result as judged by disappearance of cough and sputum, and roentgenographic evidence of resolution with no evidence of bronchiectasis or cavity, was obtained in fourteen patients, or 52 per cent of the twenty-seven instances in which drainage was utilized. Nine patients required subsequent pulmonary resection because of the persistence of an abscess following drainage. In five of the nine patients requiring subsequent pulmonary resection, the drainage was done as a matter of expediency and eventual pulmonary resection constituted a feature of the original plan of attack. Three patients obtained an unsatisfactory result from drainage as judged by persistence of cough and sputum or fistula. There was one death due to agranulocytosis following the drainage of an abscess in the right upper lobe.

*Shaw, Robert R.: Pulmonary Abscess, J. THORACIC SURG. 11: 453-466, 1942.

TABLE I. PUTRID LUNG ABSCESS
(EIGHTY-SIX UNSELECTED PATIENTS TREATED SURGICALLY)

| PROCEDURE | NUMBER | RESULTS | | | MORTALITY |
|---|---|---|---|---|---|
| | | SUBSEQUENT RESECTION | SATISFACTORY | UNSATISFACTORY | |
| Drainage of lung abscess | 27 | 9 | 14 (52%) | 3 | 1 (3.7%) |
| Drainage of empyema and lung abscess | 12 | 3 | 4 | 5 | 0 |
| Resection for active lung abscess | 52 | 1 | 43 (82.7%) | 7 | 2 (3.8%) |
| Resection for residuals of lung abscess | 8 | 0 | 8 | 0 | 0 |
| Total | 99 | 13 | 69 | 15 | 3 (3.5%) |

Drainage of a putrid empyema associated with an abscess of the lung may be considered a procedure of expediency in that further surgery at a later date may be necessary. This procedure was necessary in twelve patients, three of whom had a subsequent pulmonary resection. Drainage of the empyema and abscess led to a satisfactory result in only four of these patients. In five patients the results were considered unsatisfactory as determined by persistence of cough, sputum, residual pulmonary cavity, or bronchiectasis. There were no deaths in this group.

Pulmonary resections for active abscesses of the lung were done in fifty-two patients. Forty-three, or 82.7 per cent, of these patients obtained what was termed a satisfactory result as judged by the absence of cough, sputum, chest pain, and residual empyema. The duration of the abscesses in this group varied from two months to eleven years, the average being fifteen months. The ages of these patients ranged from 18 to 25 years. Two patients died following pulmonary resection, a mortality of 3.8 per cent.

In eight patients pulmonary resections were done for residuals of abscesses. The residuals of an abscess consist of a persistent cavity, bronchiectasis, or a persistent fistula with very little evidence of active infection. All eight patients obtained a satisfactory result, and there were no deaths in this group.

A total of three of eighty-six unselected patients treated surgically died, an over-all mortality of 3.5 per cent.

Pulmonary resections for active abscesses were done as a primary surgical procedure in thirty-five of the eighty-six patients, or 40.7 per cent. The indications for primary resection consisted of an abscess of long duration consisting of multiple or multilocular cavities which were not considered suitable for drainage. The presence of bronchiectasis, in association with an abscess or severe hemoptysis, was considered an indication for primary pulmonary resection. The types of pulmonary resection done for active abscess of the lung together with the results obtained are indicated in Table II.

Segmental resection for abscess was utilized in only three instances. All three patients developed a postoperative empyema. A satisfactory result was obtained in two patients, but the remaining patient continues to have repeated small hemoptyses. There were no deaths in the group of segmental resections.

TABLE II. PULMONARY RESECTIONS FOR ACTIVE PUTRID LUNG ABSCESS

| TYPE OF RESECTION | NUMBER | PREVIOUS SURGERY | POST-OPERATIVE EMPYEMA | RESULTS | | MORTALITY |
|---|---|---|---|---|---|---|
| | | | | SATISFACTORY | UNSATISFACTORY | |
| Segmental resection | 3 | 0 | 3 | 2 | 1 | 0 |
| Lobectomy | 35 | 14 (40%) | 9 (25.7%) | 29 | 5 | 1 |
| Pneumonectomy | 14 | 3 (21.4%) | 3 (21.4%) | 12 | 1 | 1 |
| Total | 52 | 17 (32.7%) | 15 (28.8%) | 43 (82.7%) | 7 (13.5%) | 2 (3.8%) |

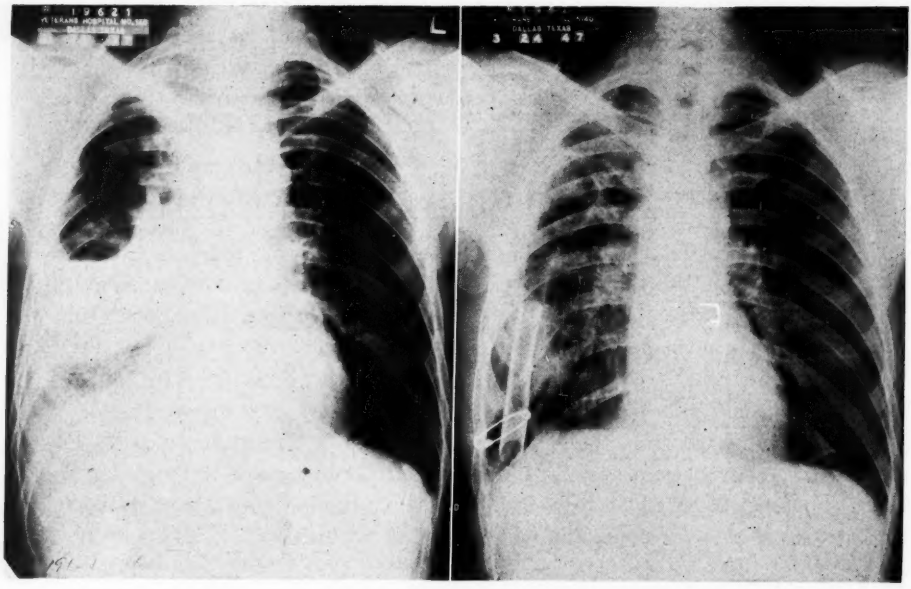
Thirty-five lobectomies were done for patients having active abscesses, fourteen of whom had had previous surgery consisting of drainage in thirteen instances and a previous lobectomy in one. A postoperative empyema developed in nine patients, or an incidence of 25.7 per cent in this group. Twenty-nine of these patients were considered to have obtained a satisfactory result. Five patients were considered to have an unsatisfactory result. There was one death, due to severe hemorrhage from the chest wall to which the abscess was densely adherent. Total pneumonectomies for active putrid abscesses were done in fourteen patients, three of whom had had previous surgery consisting of drainage. There were three postoperative empyemas, or an incidence of 21.4 per cent. Twelve of the fourteen patients were judged to have a satisfactory result in so far as is possible following a complete pneumonectomy. One patient obtained an unsatisfactory result following the removal of a lung for multiple abscesses by the mass ligation technique. He developed an empyema cavity with a persistent fistula which has persisted in spite of a complete thoracoplasty. Reamputation of the bronchial stump will be necessary to effect a satisfactory result. One patient died immediately postoperatively due to cardiac arrest.

Seventeen, or 32.7 per cent, of fifty-two patients undergoing pulmonary resection for active abscesses had had previous surgery consisting mainly of drainage. Fifteen patients, or 28.8 per cent, developed a postoperative empyema. There were two deaths, a mortality of 3.8 per cent. The individual ligation technique of pulmonary resection was used in all instances except for one patient in whom a mass ligation seemed necessary because of the poor condition of the patient.

Residuals of an abscess were resected in eight patients. Two segmental resections and six lobectomies were done. All eight patients obtained a satisfactory result. Two patients had had previous drainage. There were no deaths in this group.

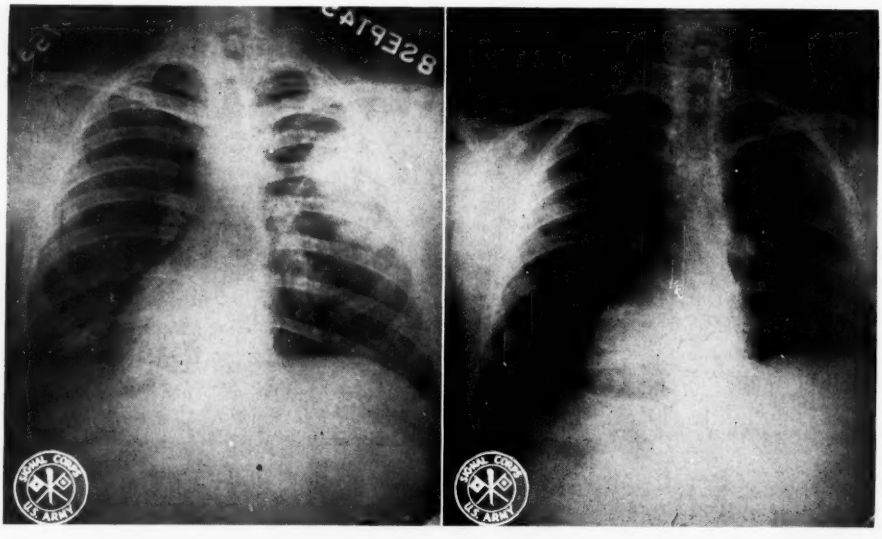
TABLE III. RESECTIONS FOR RESIDUALS OF PUTRID LUNG ABSCESS

| TYPE OF RESECTION | NUMBER | PREVIOUS SURGERY | POST-OPERATIVE EMPYEMA | RESULTS | | MORTALITY |
|---|---|---|---|---|---|---|
| | | | | SATISFACTORY | UNSATISFACTORY | |
| Segmental resection | 2 | 0 | 0 | 2 | 0 | 0 |
| Lobectomy | 6 | 2 | 0 | 6 | 0 | 0 |
| Pneumonectomy | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 8 | 2 | 0 | 8 | 0 | 0 |



*A.* *B.*

Fig. 1.—*A*, Roentgenogram of a patient with a large gangrenous abscess involving the right upper and lower lobes of the lung. *B*, Roentgenogram of the same patient two months after an expedient drainage. A right upper lobectomy and a segmental resection of the dorsal segment of the right lower lobe was done later for removal of the residual cavity.




*A.* *B.*

Fig. 2.—*A*, Roentgenogram illustrating a putrid abscess of the right upper lobe of the lung of nine months' duration. *B*, Roentgenogram of the same patient four months after a primary right upper lobectomy. (Photograph by U. S. Army Signal Corps.)

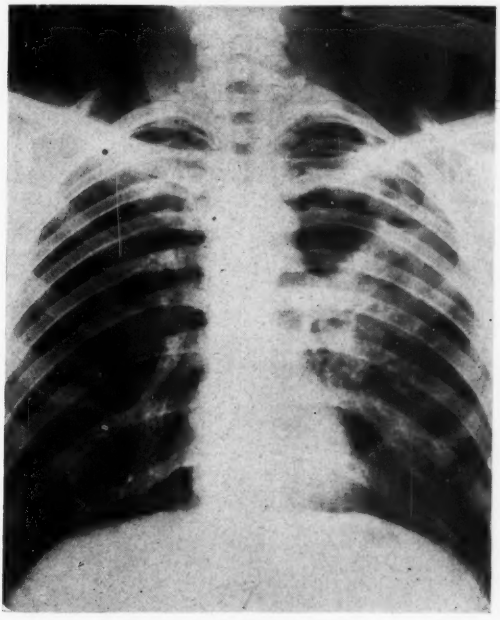


Fig. 3.—Roentgenogram of a patient having a putrid abscess in the left upper lobe of fourteen months' duration; a left upper lobectomy was done.

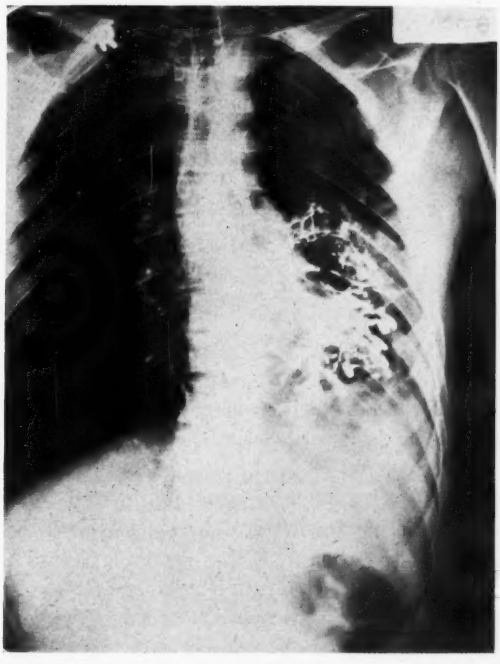


Fig. 4.—Bronchogram of a patient having multiple abscesses in the left lung of four years' duration with marked bronchiectasis; a total pneumonectomy was done.

DISCUSSION

As compared with the previous report made in 1941 by one of us, the mortality of the surgical management of putrid lung abscess has been reduced from 15.2 per cent to 3.5 per cent, and the percentage of satisfactory results or the cure rate has been raised from 57.6 per cent in 1941 to 82.7 per cent in the present series. It is believed that the increased application of pulmonary resection has been responsible for this improvement. Drainage and pulmonary resection in the surgical treatment of pulmonary abscesses are complimentary procedures and are not antagonistic. From a consideration of the pathologic

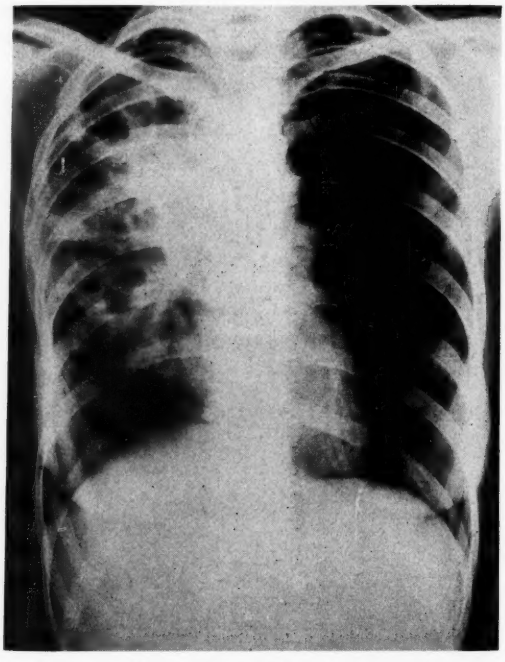


Fig. 5.—Roentgenogram of a patient with multiple abscesses of the right lung of fourteen months' duration; a total pneumonectomy was done.

features of abscess of the lung it becomes apparent that drainage alone cannot result in a high percentage of satisfactory results. We are of the opinion that drainage of an abscess should be used only in those patients in whom it is believed drainage will effect a cure or in the group in which drainage is done as a matter of expediency. In all other instances we believe that a primary pulmonary resection should be done. Following the resection for an abscess in this series, 71.2 per cent obtained a primary uncomplicated cure, and 82.7 per cent obtained an eventual satisfactory result. Cough and sputum immediately disappeared and the patient was cured of the disease by complete re-

moval of the abscess as one procedure. The convalescence following drainage is more prolonged but is justified in the interest of the conservation of pulmonary tissue in suitable instances.

It is considered possible that common use of chemotherapeutic and antibiotic agents may be a factor in the lowering of the over-all mortality as compared with the report of 1941. This has been a factor in reducing the mortality of the operative procedure through control of the pneumonitis and cellulitis associated with an abscess. However, these agents cannot be considered as a factor in preventing the development of the pathologic features of chronic abscesses of the lung. During the three-year period of the present report, we have seen fewer patients having acute abscesses than previously. It is our distinct impression that the common use of sulfonamide drugs and the antibiotic

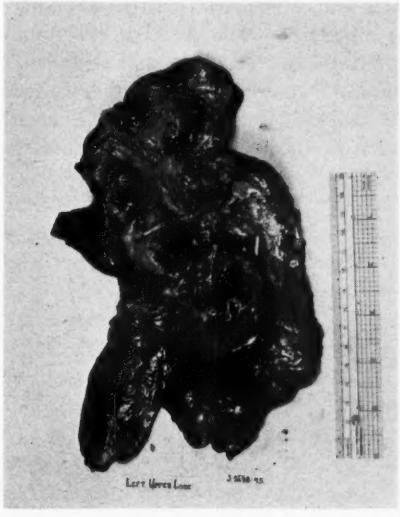


Fig. 6.—Gross pathologic specimen of putrid abscess in the left upper lobe of fifteen months' duration. Note the multilocular cavity, epithelization of the cavity walls, diffuse fibrosis, and dilated bronchi.

agents has in many instances induced a period of quiescence in an acute abscess, thereby lulling the attending physician into the belief that he has cured the abscess only to have an exacerbation occur at a later date. More patients are therefore seen during the chronic stage of the disease, thereby necessitating more pulmonary resections and fewer drainages. Chemotherapeutic and antibiotic agents are of great value as adjuncts to pulmonary resection for abscess, both as preoperative preparation and postoperative prophylaxis. Another and probably equally important factor in the reduction of the over-all mortality has been the development of a more meticulous technique of pulmonary resection as we know it today. Postoperative empyemas occurred in only 28.8 per cent of the pulmonary resections done for abscess of the lung in this series. Most of

these empyemas occurred in patients in whom a previous drainage of the abscess had been done.

It is our observation that segmental resection for abscess of the lung yields a higher incidence of postoperative empyema than does lobectomy or pneumonectomy. Segmental resection may occasionally be indicated for an abscess in the interest of preservation of pulmonary tissue, however, because of the surrounding zone of pneumonitis usually associated with an abscess, transection of lung tissue is dangerous in that infection may be left in the remaining segments.

## SUMMARY

A series of eighty-six unselected patients having putrid abscess of the lung treated surgically from 1944 to 1947 has been presented. Eighty per cent of these patients obtained a satisfactory result and the over-all mortality was 3.5 per cent. A comparison was made with a previous series of surgically treated lung abscesses reported by one of us in 1941 in which 57.6 per cent obtained a satisfactory result and 15.2 per cent died. It is believed that the increased application of pulmonary resection is largely responsible for this improvement in morbidity and mortality. The use of chemotherapeutic and antibiotic agents has undoubtedly favored the good results of pulmonary resection.

# PULMONARY RESECTION FOR CHRONIC LUNG ABSCESSES

EDWARD M. KENT, M.D., PITTSBURGH, PA., AND (BY INVITATION)
FRANK S. ASHBURN, M.D., ROCHESTER, MINN.

THE management of chronic lung abscess has always presented one of the more trying problems encountered by the surgeon. This has been especially true of multiple abscesses since these have not responded satisfactorily to drainage operations. Even the solitary chronic abscess has not responded to treatment by drainage in an entirely satisfactory fashion. The morbidity is usually of long duration, the mortality has been of appreciable moment, and the end results have fallen short of the desired goal in many instances.

Resection of the diseased lobe or lobes has achieved acceptance as the treatment of choice when surgical intervention becomes necessary in multiple, diffuse or multilocular chronic pulmonary abscesses. Nineteen such cases are included in this presentation in order to demonstrate that the mortality rate can now be expected to be reasonable, the morbidity can be anticipated to be held at a low level, and the end results should be very satisfactory.

Eleven cases of solitary chronic lung abscess are presented; each patient was treated successfully by lobectomy rather than by drainage of the abscess. Perhaps resection has not been accepted as yet as the treatment of choice for chronic lung abscesses which are characterized by a solitary cavity, and it is in anticipation of free expressions of opinion on the matter that these cases are described.

A good deal of dissatisfaction with the results of drainage of chronic abscesses led the authors to adopt the policy of elective resection. These disappointing results included very prolonged morbidity, often extending into several months; an appreciable mortality rate; the tendency for these lesions to recur after drainage; and, above all, the consistent residual suppurative changes persisting at the site of the abscess after drainage. Small residual cavities and bronchiectasis of varying degree and extent (Fig. 1) were demonstrated by bronchography in each of six patients studied because of persistent cough and expectoration.

The cases to be presented are arranged in three groups as follows:

Group I includes eleven patients who presented multiple lung abscesses which extended beyond the confines of a single lobe of one lung. The ages of these patients ranged from 21 to 64 years and the duration of the disease from 5 to 42 months with an average duration of 18.0 months (Table I). All were subjected to total pneumonectomy after failure of conservative therapy.

A single patient developed a bronchial fistula after discharge from the hospital. He was readmitted, and the presence of the fistula was established but infection of the pleural space did not occur. The fistula was closed by means

Read at the Twenty-Seventh Annual Meeting of the American Association for Thoracic Surgery, St. Louis, Mo., May 28, 29, and 30, 1947.

TABLE I. GROUP I, PNEUMONECTOMY FOR MULTIPLE ABSCESSES INVOLVING MORE THAN A A SINGLE LOBE

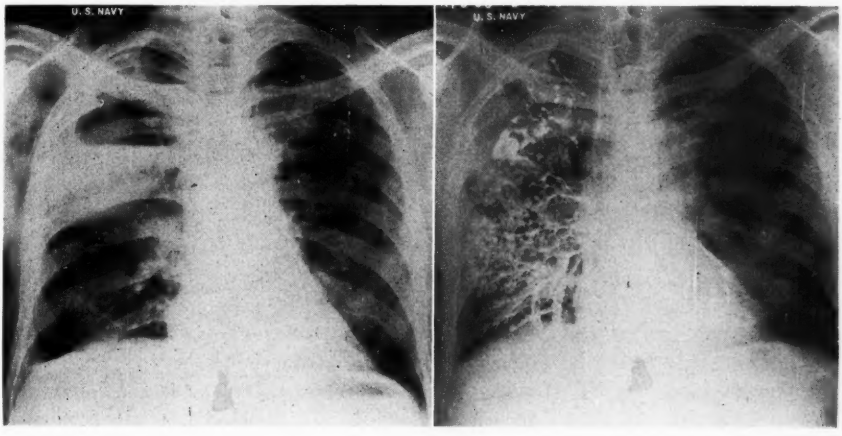
| CASE | SEX | AGE (YR.) | DURATION (MONTHS) | OPERATION | RESULT |
|---|---|---|---|---|---|
| 1. (B. F.) | M | 26 | 42 | R. pneumonectomy | Well |
| 2. (L. H.) | M | 21 | 15 | R. pneumonectomy | Death ninth post-operative day |
| 3. (J. J.) | M | 64 | 9 | L. pneumonectomy | Well |
| 4. (J. K.) | M | 27 | 18 | R. pneumonectomy | Well (Bronchial fistula after operation) |
| 5. (R. N.) | M | 56 | 9 | L. pneumonectomy | Well |
| 6. (R. D.) | F | 59 | 11 | L. pneumonectomy | Well |
| 7. (A. H.) | M | 37 | 38 | R. pneumonectomy | Well |
| 8. (V. B.) | M | 56 | 13 | L. pneumonectomy | Well |
| 9. (L. G.) | M | 46 | 40 | L. pneumonectomy | Well |
| 10. (C. D.) | M | 57 | 8 | R. pneumonectomy | Well |
| 11. (L. R.) | M | 54 | 7 | L. pneumonectomy | Well |
| 12. (R. S.) | M | 59 | 5 | L. pneumonectomy | Well |

*Summary of Table:* Twelve cases. Age range from 21 to 64 years. Duration range from 5 to 42 months. Five cases on right side, seven on left. One death on ninth postoperative day of extensive pneumonitis of remaining lung, result of gross contamination at operation. One postoperative bronchial fistula but empyema did not occur. Mortality rate this group, 8.3 per cent.

of a pedicled muscle flap which was applied to the fistula opening on the surface of the mediastinum. Five weeks later the fistula reopened and is still open although once more empyema has failed to take place. This patient suffers very little from the presence of the fistula and is not hospitalized. Uultimately, a thoracoplasty will be required if spontaneous healing does not take place. The circumstances in this case are worth recounting briefly. The symptoms of pulmonary suppuration had been of eighteen months' duration. He had been hospitalized four months before pneumonectomy for an acute putrid empyema on the right side which was drained. The underlying multiple lung abscesses were revealed as the empyema healed. Bronchoscopy was performed on several occasions, and a stenosis of the right main bronchus was seen. All efforts to improve the condition of the patient by means of conservative measures failed, and he continued on a progressive, febrile, toxic course. Resection of the lung appeared to offer the only hope of cure, in fact of saving his life. It was a very difficult procedure because of the putrid empyema which had only recently healed. Identification of the hilar structures entailed prolonged dissection and, despite this, the right upper lobe bronchus was divided, and the main bronchus was again divided just below the upper lobe branch. This necessitated repair of two bronchial stumps, neither of which could be buried satisfactorily. These conditions may well explain the occurrence of the fistula. It is interesting to note that examination of the specimen disclosed a cork disk the size of the gasket on a pop-bottle cap lodged in the right main bronchus. The stenosis had occurred about this foreign body. The patient denies any knowledge of how or when the incident took place.

There was one death in this group. This patient was a 21-year-old man who had suffered from multiple abscesses of the right upper and lower lobes for fifteen months (Fig. 2). During this period surgical intervention had been attempted elsewhere on two occasions. An effort to perform drainage of the

lesions had been made without success. Later a lobectomy was undertaken but was abandoned after some effort in that direction. He was seriously ill, and all conservative measures failed to provide improvement. Pneumonectomy was decided upon and was carried out. The anesthetist was unfamiliar with the management of these extremely difficult cases, and at one point the tracheobronchial tree filled with contents from the abscesses and asphyxia ensued. One




*A.* *B.*

Fig. 1.—*A*, Chronic solitary pulmonary abscess of right upper lobe. *B*, Lipiodol installation reveals residual cavitation and bronchiectasis at site of abscess. Moderate symptoms persist.

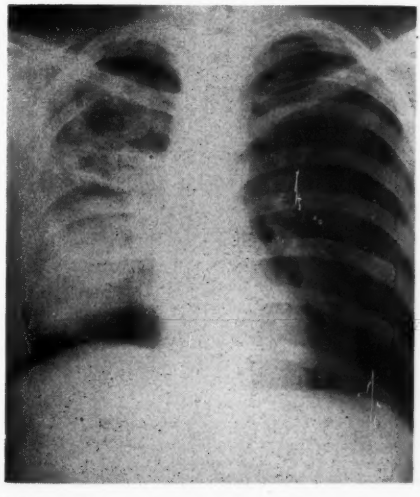


Fig. 2.—(Case 2) Multiple chronic pulmonary abscesses of right upper and lower lobes. Two previous operations elsewhere.

of us dropped out of the operating team and bronchoscoped the patient. The trachea and bronchi were found to be filled with pus and thick, puttylike particles which were aspirated with difficulty. The contents of the abscesses continued to be disgorged into the airway until the right main bronchus was clamped, hence it was necessary to keep the bronchoscope in place throughout the period required to achieve this step in the resection. A diffuse pneumonitis occurred in the remaining lung within thirty-six hours after operation and resulted in death on the ninth day.

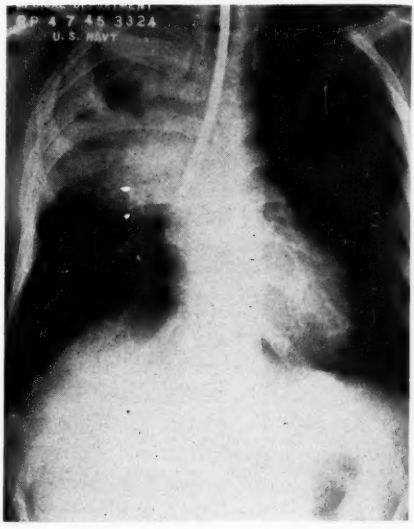
The ten patients which remain passed through uncomplicated convalescence periods and have made full recoveries. While we believe in early ambulation, we have set no definite interval for allowing patients out of bed after pulmonary resection. As a matter of principle, a patient is made ambulatory as soon as he expresses an interest in getting out of bed, if there are no contraindications. This is usually between the third and fifth day after operation. These patients were discharged from the hospital at periods varying between ten and sixteen days after surgery.

Group II includes seven cases of multiple abscesses confined to one pulmonary lobe. The age range varied between 25 and 46 years. The duration of symptoms ranged from nine to thirty-nine months with an average of 20.5 months for the group. All were subjected to lobectomy (Table II). There were no postoperative bronchial fistulas or infections of the pleural space. There was one death which occurred on the operating table due to asphyxia caused by hemorrhage into the tracheobronchial tree from the diseased lobe. This patient had been under treatment elsewhere for thirty-nine months because of multiple abscesses of the right upper lobe (Fig. 3). Two drainage operations had been performed without favorable results. Daily hemoptysis had been present for five months, and these were of such magnitude that repeated blood transfusions were required. The situation was indeed desperate; nevertheless, an attempt at resection was elected. The fatal hemorrhage occurred as the chest was being opened, and it caused death by asphyxia. It is possible that earlier recognition of the cause with immediate bronchoscopy would have prevented death at that time. Postmortem examination revealed that lobectomy would have been virtually im-

TABLE II. GROUP II, LOBECTOMY FOR MULTIPLE ABSCESSES CONFINED TO A SINGLE LOBE

| CASE | SEX | AGE | DURATION (MONTHS) | OPERATION | RESULT |
|---|---|---|---|---|---|
| 13. (G. N.) | M | 26 | 17 | Middle lobe | Well |
| 14. (R. H.) | M | 31 | 11 | Middle lobe | Well |
| 15. (J. M.) | M | 44 | 9 | Middle lobe | Well |
| 16. (S. A.) | M | 25 | 19 | Left upper lobe | Well |
| 17. (J. S.) | M | 36 | 39 | Thoracotomy | Death on table of asphyxiation from hemorrhage |
| 18. (A. W.) | M | 24 | 29 | Left lower lobe | Well |
| 19. (A. M.) | M | 46 | 20 | Right upper lobe | Well |

*Summary of Table:* Seven cases. Age range 25 to 46 years. Duration range from nine to thirty-nine months. No postoperative bronchial fistulae or empyemas. One death on the operating table due to hemorrhage from the abscesses and asphyxia. Mortality rate for this group is 14.3 per cent.



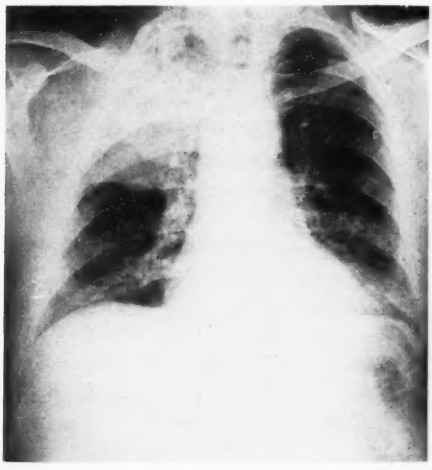
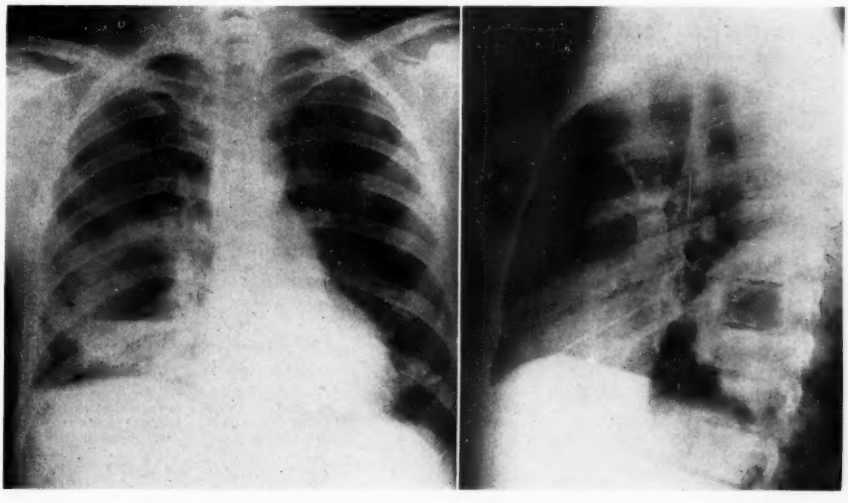



Fig. 3.—(Case 17) Multiple chronic pulmonary abscesses of right upper lobe. Catheter in trachea in effort to fill diseased lobe with iodized oil. Two previous operations elsewhere.

Fig. 4.—(Case 19) Multiple chronic pulmonary abscesses of right upper lobe. Drainage operations performed twice elsewhere.



*A.* *B.*

Fig. 5.—*A* (Case 23), Solitary pulmonary abscess of right lower lobe, five months' duration. *B*, Lateral view, same patient.

possible. The six patients who remain in this group passed through the postoperative convalescence period without complications, were out of bed no later than the seventh day, and were ready to leave the hospital on or before the seventeenth day after operation.

Three of these patients had received at least one previous attempt at surgical drainage (Fig. 4). Two of them had been drained upon two previous occasions. Technical problems are greater under such circumstances, particularly because the lobe becomes extremely adherent to the chest wall at and about the site of drainage and because perforation of the diseased lobe at the site of previous drainage is quite likely to occur with resulting contamination of the pleural space.

Group III includes eleven patients with solitary abscess of the lung, each of whom was treated by lobectomy (Table III). The ages of these patients varied from 17 to 56 years and the duration of disease from four to thirty-seven months with an average duration of 11.5 months. Two of these patients developed small bronchial fistulas with empyemas of rather limited size after operation. There were no deaths in this group, and all are well at this time. A typical case from this group is displayed in Fig. 5. A large thick-walled abscess was present which was easily accessible for surgical drainage; nevertheless, lobectomy was elected as the treatment of choice and this particular case was one of the most difficult to resect in this entire group. The postoperative convalescence was entirely satisfactory, and the patient left the hospital on the tenth day after operation.

TABLE III. GROUP III, LOBECTOMY FOR SOLITARY CHRONIC PULMONARY ABSCESS

| CASE | SEX | AGE | DURATION (MONTHS) | OPERATION | RESULT |
|---|---|---|---|---|---|
| 20. (R. W.) | M | 24 | 5 | Right lower lobe | Well |
| 21. (J. C.) | M | 20 | 9 | Left lower lobe | Well |
| 22. (V. H.) | F | 18 | 26 | Left lower lobe | Well |
| 23. (J. M.) | M | 27 | 5 | Right lower lobe | Well |
| 24. (D. M.) | F | 34 | 37 | Right lower lobe | Well |
| 25. (G. S.) | F | 17 | 4 | Right upper lobe | Well (Bronchial fistula with empyema) |
| 26. (F. G.) | M | 36 | 7 | Right upper lobe | Well |
| 27. (B. J.) | M | 19 | 4 | Right lower lobe | Well |
| 28. (J. B.) | M | 46 | 8 | Right lower lobe | Well |
| 29. (S. R.) | M | 56 | 18 | Right upper lobe | Well |
| 30. (Z. M.) | F | 43 | 5 | Right lower lobe | Well (Bronchial fistula with empyema) |

*Summary of Table:* Eleven cases. Age range 17 to 56 years. Duration range four months to thirty-seven months. Two developed postoperative bronchial fistula with empyema. No deaths occurred. Two of these cases had been drained elsewhere with recurrence of the abscess or failure to heal.

The choice of resection rather than surgical drainage for patients presenting a solitary pulmonary abscess has been deemed justifiable due to the unfavorable results achieved by the latter means. The series is small, and further experience may prove that the risk is greater than that entailed in drainage of an abscess. If that proves to be the case, we shall be compelled to revert to

drainage operations. However, if the mortality rate is found to be no higher, we feel that it will become the procedure of choice since the morbidity is greatly reduced and the end results are much more consistently of a satisfactory character.

It should be made clear that we are not choosing resection for the treatment of refractory acute pulmonary abscesses but are limiting it to use in cases of long standing, chronic pulmonary abscesses.

The role of the anesthetist is extremely important in all forms of thoracic surgery, and it is vital in cases of chronic pulmonary suppuration. Perhaps the most exacting duty which falls upon him is prompt recognition of the presence of secretions in the airway and the immediate removal of same. This often requires the frequent use of the bronchoscope during operation since catheter aspiration of the airway is inadequate in many instances.

We are convinced that penicillin has been of great value in reducing infections of the pleural space and virtually eliminating wound infections after surgery for cases of this type. Nevertheless, the most important factor in reducing postoperative suppuration has, in our opinion, been the use of the individual ligation technique for pulmonary resection.

## SUMMARY

1. Thirty cases of chronic pulmonary abscesses have been treated by pulmonary resection. Nineteen were cases of multiple diseases and eleven were of solitary abscesses.

2. Eight of these patients had received one or more previous operations for the treatment of these lesions.

3. The average age for the entire group is 33 years, minimum age 17 years, maximum age 64 years.

4. The average duration of disease in the entire series is 16.2 months, minimum duration four months, maximum forty-two months.

5. There were two deaths (6.6 per cent) in the entire series. These have been described in detail.

6. Greater experience with resection for solitary pulmonary abscess will be necessary before the safety of the procedure can be established. The end results were excellent in the eleven such cases of this series.

7. The postoperative morbidity is sharply reduced in contrast to that experienced after drainage of solitary pulmonary abscesses.

8. The end results following resection for chronic pulmonary abscess promise to be favorable with higher constancy than after drainage.

## DISCUSSION

DR. JAMES D. MOODY, Durham, N. C.—I would like to ask Dr. Paulson what incidence of contralateral and ipsilateral spread he has had in his cases of resection. I note that Dr. Kent has had some difficulty with it.

During the past several months we have been working on an instrument designed to obstruct the bronchus and prevent the spread of purulent secretions during pulmonary resections.

(Slide) On this slide is depicted the instrument which we have finally developed; you will note that it consists of a small rubber balloon mounted on the end of a double-lumen, 12 French, rubber catheter.

I am sure you are all familiar with the disadvantages of some of the instruments which have been developed in the past, namely, that they have tended to slip out of place at inopportune times. We have attempted to get around that by constructing this metal apparatus which fits around the balloon in this manner. As you note, it has several small one millimeter points at the ends. This holding apparatus, as we call it, is made in three sizes to fit the varying diameters of the bronchi where the balloon is placed.

(Slide) On this next slide is depicted the manner in which the points of the holding apparatus are embedded in the bronchial mucosa. On deflation of the balloon, the points resume their original position, and the entire apparatus may be withdrawn from the bronchus without harm to the bronchial mucosa.

The proximal end of the double lumen catheter is connected to a sleeve valve which, when closed, maintains inflation of the balloon. This enables us to place the balloon in the bronchus and then remove the bronchoscope without fear of dislodging the balloon.

(Slide) This is a diagram of the function of the balloon in a theoretical patient with lung abscess. You will note the large lung abscess with a fluid level and the balloon obstructing the left lower bronchus, thus sealing off any drainage from the abscess.

For a pneumonectomy on the left side, the balloon is placed between the carina and the left upper lobe orifice. For a pneumonectomy on the right, it should be placed at this spot, and at the corresponding levels for resection of the right middle and/or lower lobes.

During the past ten months we have employed this instrument in a series of twenty-three cases in order to work out a technique for the instrument. Of these twenty-three cases, approximately one-half of them were done for bronchiectasis, five for tuberculosis, and the remainder for carcinoma and lung abscess. Bronchial occlusion has been perfect in all cases. This has been evidenced either by atelectasis of the affected lobe or by lack of inflation on positive pressure anesthesia.

I failed to mention that the instrument has a twofold purpose. It is designed to obstruct the bronchus to the affected lobe, and also to produce atelectasis distal to the balloon in the bronchus. The atelectasis, of course, gives the surgeon much more room within which to work; he may, therefore, maintain inflation of the upper lobe on that side if he so desires, providing he is doing a lobectomy.

There has been no interference with anesthesia in any of our cases. In fact, anesthesia has been considerably aided through obviating tracheobronchial suction. There have been no harmful effects in any of the patients. Four of the patients had thoracotomies without removal of pulmonary tissue.

The mechanics of placement and operation of the instrument have proved quite simple over a period of several months. The balloon has retained its primary function of remaining in place securely in all except one case. In this particular instance, the bronchus was a mass of tuberculous granulation tissue, and it was thought preoperatively that the balloon would not remain in place. However, it did so much longer than was expected.

Inasmuch as this series of patients was used in working out a technique for the use of the instrument, we have not expected, of course, 100 per cent success. We have had three contralateral spreads, all occurring in the first few cases in the series, and fortunately, all quite minimal. There are certain factors explained in the paper on this subject which we believe may account for the spreads having occurred at the time when the balloon was not in the bronchus.

The results in these cases are considered quite satisfactory, and we hope to employ the balloon, along with improved methods of bronchoscopy and pre- and postoperative care, in a large series of patients during the coming year, in order to determine whether or not the instrument may reduce the incidence of contralateral spread.

DR. DUANE CARR, Memphis, Tenn.—I am sure that most of the men would agree that resection is the treatment of choice for multiple lung abscesses scattered throughout a lobe or entire lung.

Dr. Kent has pointed out one of the difficulties which may arise in the execution of such a procedure, that of the excessive amount of secretion which will produce flooding of the bronchi of the opposite lung. Many here have become convinced of the advantages of the face-down position of the patient on the operating table in such a situation.

However, tables designed for this purpose, such as the one demonstrated at this meeting, are not available to all of us.

Dr. Skinner and I were faced with this problem in a young girl who had extensive abscesses scattered throughout one lung, and although we had bronchoscoped the patient previous to the induction of anesthesia and during the operation, we were forced to discontinue the procedure before its completion.

We were forced to improvise an attachment to permit a face-down position and found an ironing board with six inch blocks to support it adequate for the purpose. A section of the board was cut off with a saw to permit the incision to be extended around to the anterior axillary line. In this fashion the patient was elevated from the table and adequate room was allowed for an excellent exposure.

Ten days later Dr. Skinner and I were able to complete the operation and the ease with which this patient went through the anesthetic and the operation was amazing. No difficulty was encountered in keeping the trachea and bronchi clean and the patient made a satisfactory recovery.

So for those of you to whom a thousand dollar table especially adapted to the face-down position is not available, an ironing board, a couple of six inch blocks, and a saw will permit you to operate upon these patients without the complications of flooding the contralateral lung with pus.

DR. RALPH A. DORNER, Iowa City, Iowa.—At the University of Iowa we have a series of twelve pulmonary resections for abscess of the lung since 1941. Two of these were pneumonectomies and others lobectomies.

There was one mortality. This death occurred in the case of a white woman 28 years old who had been seen at the University Hospital off and on since 1938 with bilateral lung abscesses. Her chief symptoms had been recurring attacks of pleurisy and hemoptyses. In 1943 she spent eleven months in the Iowa State Tuberculosis Sanatorium, where many studies for tubercle bacilli, including cultures and guinea pig inoculations, were negative. During this stay, a right phrenemphraxis was performed and there was a resultant temporary cessation of hemoptyses. However, in April 1945, they again recurred and became frequent and severe.

Hoping to eliminate the cause of her bleeding, bilateral lobectomies were advised. On Aug. 9, 1946, I did a right thoracotomy. Both the middle and lower lobes were found to be involved in a marked inflammatory process and were, therefore, extirpated. Immediate postoperative bronchoscopy revealed blood coming from the *left* main-stem bronchus. Studies of the tissue removed showed a number of abscesses with a central necrotic area containing foul, thick, greenish pus surrounded by a 3 to 5 mm. zone of dense connective tissue. There was some associated bronchiectasis, atelectasis, and pneumonia. Cultures of pus from the cavities revealed *Monilia albicans,* as had been found once in her sputum preoperatively. Subsequent sputum studies revealed large amounts of the same organism in numerous specimens.

The patient had a rather stormy postoperative course. X-rays showed clouding of both lung fields—apparently due to a spread of infection from the hemorrhage. This appeared to increase, although the patient's condition seemed to improve. The patient began having paroxysms of marked dyspnea and insisted that she was going to die. She did die during one of her attacks of paroxysmal dyspnea on the twenty-first postoperative day. Unfortunately, we were unable to obtain permission for an autopsy and thus were unable to study the case further as to whether her abscesses and death had been due to *Monilia albicans.*

A second case of particular interest to us was a white man 45 years old. He had had the onset of a lung abscess following the "flu" in June, 1946. He was admitted to the Iowa State Tuberculosis Sanatorium on Nov. 18, 1946, because of the suspicion of tuber-

culosis due to the cavity in the right upper lobe. He was raising from two to five cupfuls of foul-smelling sputum per day. Many studies for tubercle bacilli were negative. Likewise, frequent bronchoscopic examinations failed to reveal the presence of a tumor.

Feeling that this chronic lung abscess obviously would not respond to simple drainage, and fearing that we might be dealing with a carcinoma, we felt that this patient deserved exploration. I explored him in February of this year, and found a woody right upper lobe. The process, confined entirely to the upper lobe, appeared inflammatory and there was no evidence of node involvement. Consequently, I carried out a right upper lobectomy.

(Slide) The examination of the specimen postoperatively revealed a very marked inflammatory reaction within the entire right upper lobe, with the cavity shown in this slide partially opened. Grossly, the pathologist noted numerous "tiny golden dots" which microscopically were interpreted as actinomycetes.

Some of the tissue was taken immediately to the bacteriology laboratory, and their studies revealed the presence of actinomycosis.

This patient's postoperative course was somewhat disturbing for a few days. He raised a fairly large amount of sputum, and we had the impression that he had an atelectasis of his middle lobe, probably due to distortion of the middle lobe bronchus. I had placed a water-sealed catheter into the thoracic space at operation. The water seal was converted to active suction, and this apparently relieved the distortion of the middle lobe bronchus with very rapid disappearance of the atelectasis and obliteration of the apical space.

The patient's postoperative course from then on was satisfactory. He was given penicillin, 50,000 units every four hours, until his discharge on the twenty-second postoperative day. He has been seen several times since discharge and appears quite well.

DR. ROBERT R. SHAW, Dallas, Texas.—Surgical drainage of an acute pulmonary abscess yields a highly satisfactory result in almost every case, with maixmum preservation of pulmonary function.

There seem to be two factors that are leading to the increased application of resection in the treatment of this disease. First, of course, is the factor of the increased safety of pulmonary resection, due to refinements in technique of the handling of the hilum, of anesthesia, and in adequate blood replacement. Second, there is the factor of the increased use of antibiotics in the early treatment of this disease. We all know that antibiotics, chiefly penicillin and the sulfa group of drugs—I, myself, have had no experience with streptomycin—will induce in many of these patients a period of quiescence which lulls the physician into feeling that the patient is probably all right. Only later it will be found that thas patient continues to have symptoms and flare-ups of the disease, and at this time it will be found that the complicated features of this disease have already become established. Once these features have become established, simple drainage of the abscess will usually not alone effect a cure. That, of course, brings us into the increased use of pulmonary resection.

I want to congratulate Dr. Kent and Dr. Ashburn on their very low percentage of empyema. We have not been able to achieve as low a percentage as they have achieved. I can look back upon several cases in which the occurrence of the empyema was definitely due to a technical fault of my own. In two patients having pneumonectomies, I left an unnecessarily long bronchial stump, and I am sure that contributed to a bronchial fistula with empyema. They subsequently received good results, following a complete thoracoplasty for the empyema. In one other patient—much the same as Dr. Kent described in telling of the fatality, a patient who had had a previous drainage and also a previous attempted resection—while operating under unfavorable circumstances in a strange hospital, I had to use mass ligation technique to get out of the chest expeditiously and save the patient's life. This resulted in a very long stump, in that the bronchi were actually cut at the branches and not at the main bronchus. This patient is alive, but does have symptoms due to this long bronchial stump, and I am planning to amputate it at a later date. I hope that eventually he will obtain a good result.

In other cases it may be thought wise even to invite the complication of an empyema in order to preserve pulmonary function. I do not think that we should be concerned only with the preservation of pulmonary function in people of middle age, or perhaps the elderly group. We hope that the person of 20 and 30 years will arrive at the age of 50 or 60, and then pulmonary function will become very important to him. So that in every patient I think we should strive to preserve as much normal pulmonary tissue as possible. Because of that, I have at times elected to break into infected areas along fissure lines, where the only extension into the neighboring lobe is along a fissure line, and in that way I have obtained a postoperative empyema. I do not feel that the increased morbidity that this patient incurs is important when considering, also, the better result that he will get from the residual pulmonary tissue that was left behind.

DR. ANTHONY R. CURRERI, Madison, Wis.—I believe the essayists should be commended for demonstrating the low rate of mortality associated with pulmonary resection in the treatment of chronic lung abscess.

We welcome this discussion, because for a long time we entertained a notion that our approach to this problem was a very radical one. We have employed pulmonary resection in chronic lung abscesses since 1939. Originally, it was used in instances of multilocular abscesses because of high mortality and morbidity.

With the introduction of the individual ligation of the hilar structures, there was a tremendous improvement in the mortality and morbidity rate. With the refinements in anesthesia, as mentioned by Dr. Shaw, and improvements in pre- and postoperative care, and our own greater experience in pulmonary resection, the operation is now relatively safe.

We believe it is the operation of choice for chronic lung abscess, because, first, it eliminates the disease immediately; second, there is no possibility of the development of sequelae such as bronchiectasis; third, the disturbing complications of hemorrhage, embolic brain abscesses, and the persistent and annoying bronchopleural fistula are done away with; and fourth, we do away with the prolonged convalescence.

Recently we received the pulmonary resections of the past two years, and noted thirteen cases of chronic lung abscess. We did not include any case of extensive bronchiectasis with marked alveolar attacks, nor congenital cystic lungs with secondary infection.

Of this group of thirteen, there were seven on the right side and six on the left side. The duration of symptoms was from three months to three years. The average stay in the hospital was seventeen days, with the shortest period ten days, postoperatively, and the longest twenty-four days.

We believe the immediate results have been very good, although a final statement regarding prognosis cannot be made until a few years have elapsed. There has been no fatality in our series.

I would like to mention that in regard to control of sputum we have employed a Trendelenburg position of 20 degrees.

DR. EDWIN J. GRACE, Brooklyn, N. Y.—In the early summer of 1943 I had the opportunity of reviewing the work on aerosols being done by Dr. Vernon Bryson as a civilian scientist doing research for Chemical Warfare Service at Cold Spring Harbor. I subsequently became associated with him and we endeavored to see what could be done in furthering the use of aerosol therapy as a method of treating pulmonary disease.

We concluded from animal experiments that a more efficient method of using aerosols might be to depend not on antibiotics alone, but to use them with wetting agents (or detergents), thereby possibly increasing the penetration of suppurative material and providing certain more obvious advantages which I will specify in a moment.

If we come back to the fine philosophy so strongly emphasized yesterday by Dr. Graham and live with fundamentals we rarely go wrong. Following this reasoning we observed, and put to use clinically the observations of Dr. Demerec, the Director of the Department of Genetics, Carnegie Institution of Washington. He has shown that there is a possibility of

resistant strains developing if inadequate amounts of penicillin are employed. I might also say that this significant observation was noted in an editorial in the J. A. M. A. If we are going to employ antibiotics at all we must use them in large and adequate doses. Failure to do so may account for the comment sometimes heard that aerosol therapy produces clinical improvement that is too often followed by remission. The antibiotic must be brought in direct contact with the organism if you are going to eliminate infection. Florey has constantly emphasized this fundamental.

With our specific problems of pulmonary infection, we must realize that if we give antibiotics parenterally, only a small percentage actually reaches the infecting organism in the lung. The ideal method, we feel, is to use parenteral injection only as a secondary supplement to the infinitely more important fundamental of topical application.

Depending on the disease involved, we feel that more effective treatment for suppurative disease of the lung may be obtained by aerosol therapy, using penicillin or streptomycin, with combinations of the two where indicated by bacteriologic findings. Our present clinical results reveal that the use of a suitable detergent as a vehicle for inhaled antibiotics may be the method of choice. Use of detergents is based on the findings of Dr. Bryson that the activity of penicillin, and, to a lesser extent, streptomycin, may be significantly enhanced by detergents as demonstrated by experiments in vitro and upon animals with pulmonary disease. In addition, the possibility of increased penetration and the specific germicidal effect of certain detergents, such as members of the quarternary ammonium series upon antibiotic resistant organisms, must be considered in preparing active antibacterial preparation designed to minimize the likelihood of resistant strains becoming established as clinical entities. In particular, it is important that doses of penicillin and detergent that will reduce but slightly the number of pathogenic bacteria when used separately may completely eliminate the bacteria when an antibiotic-detergent combination is employed. The effect on staphylococci and pneumococci can be shown to be far more than additive and corresponds to the process ordinarily defined as synergism. The therapeutic result may then be more favorable than might be anticipated from the sum total of the antibacterial substances used. We use penicillin with streptomycin in a detergent which is a moderate bactericide and in addition, by mouth, we very often use some of the sulfa derivatives.

DR. RALPH B. BETTMAN, Chicago, Ill.—We would like to have you state the kind of detergent that you used.

DR. GRACE, Brooklyn, N. Y.—We have used an extremely efficient detergent dealing with cases of chronic osteomyelitis, namely Aerosol O.T. or Aerosol Wash., closing twenty-four out of twenty-nine cases. These chemicals should not be confused with the general term, aerosol . . . meaning a suspension of fine particles in a gas.

In our cases of pulmonary suppuration, we have used Zephiran chloride 1:1,000 aqueous solution as a vehicle for antibiotics. We dissolve 300,000 units of penicillin in 3 c.c. of Zephiran chloride or add 300,000 units of streptomycin to 100,000 units of penicillin in Zephiran depending upon the diagnosis. The patient inhales aerosol every six to eight hours, using a nebulizer operated from an oxygen tank. We make it a point that the patient exhales forcibly and then breathes very, very deeply. Zephiran is a more potent germicide than Aerosol O.T. but a less efficient wetting agent.

The perfect detergent is one which will do three things: (1) act independently as a germicide; (2) reinforce antibiotic activity by synergistic effect, and (3) act as a penetrating agent to insure contact with necrotic substance. We feel that with an efficient detergent we might be able to pentrate he necrotic material of which Dr. Block has spoken.

In a very limited series of cases of pulmonary tuberculosis (eleven), we have three patients with large cavities who were freed of tubercle bacilli and whose cavities were closed after treatment with antibiotics ranging from four weeks to nine weeks, employing a detergent and producing synergistic action in the method described a moment ago. The other eight cases have shown improvement but at this early date it is not possible to make a sound evaluation.

In closing, I want to make an urgent plea. I would very strongly recommend that, as a prophylactic measure in itself, when any suppuration is involved, you use this method as an excellent preoperative preparation, and I think many of the men will be amazed at how frequently some of their lung abscesses may disappear if treated on this basis, using detergents. Certainly, before any major operative procedure for tuberculosis or other suppurative disease of the lung if performed, the conservative and nonmutilating method of antibiotic-detergent aerosol therapy should be used.

DR. J. KARL POPPE, Portland, Ore.—I have been interested in the problem of the comparative mortality of drainage and resection in lung abscesses for some time and have attempted to review a long series of cases at Barnes Hospital in St. Louis to get a more accurate estimate of that comparison.

In reviewing this series I found great difficulty in differentiating lung abscesses and bronchiectasis. That may sound peculiar, but a number of the chronic lung abscesses we resected showed only bronchiectasis on the pathologic sections, the distinction there being whether or not the cavity or cavities were lined by epithelium. That distinction or that state of the abscess bore a very definite relationship to the mortality rate on resection.

The undrained abscesses or poorly or inadequately drained abscesses had a mortality rate that was approximately twice that of the resections for bronchiectasis. That mortality varied considerably from year to year. The series went back to 1920, at which time the mortality rate for both lesions was considerably higher. It decreased progressively during the period up until about 1942, but the comparison was still about 50 per cent higher for the undrained abscesses.

After a cautery pneumonotomy had been performed in a certain number of these cases, even though a lobectomy was still required, the pathology was entirely different. We no longer had a true abscess on pathologic examination. We had epithelium-lined, well-drained cavities, which really constituted bronchiectasis. This situation may have changed now, with the reduction in virulence of the organisms by penicillin. I thought it was very interesting that the mortality varied so much with the condition of the abscesses, depending largely on previous drainage and chronicity.

DR. OTTO C. BRANTIGAN, Baltimore, Md.—I hesitate to prolong the discussion, but I think the essayists should be commended on their very excellent work and its presentation. I am sure there is no question in the minds of the members of this society concerning the efficiency or the desirability of pulmonary resection in the treatment of chronic lung abscess. Surgical drainage of chronic lung abscess in the past resulted in a mortality rate of 35 to 60 per cent. With a mortality rate as low as that reported by the authors, pulmonary resection by comparison is a very conservative method of treatment.

Aside from the lower mortality and the higher percentage of patients cured by pulmonary resection or chronic lung abscess, such a method of treatment is a safeguard against carcinoma of the lung associated with lung abscess. Often it is impossible definitely to eliminate carcinoma of the lung when lung abscess is present. During the past two years I have started the operation for chronic lung abscess only to find in three patients an associated carcinoma when the thorax was opened. In each case the lung was removed.

In my experience there has been no difficulty with spread of infection to the other side, but in the past two years patients have been placed in the face down position during operation. A special operating table has not been available but the neurosurgical cerebellar attachment for the usual operating table has been used and found quite satisfactory.

DR. DONALD L. PAULSON, Dallas, Texas.—In the presentation of our material, I neglected to state that the individual ligation technique was used in all cases except for this one case which Dr. Shaw described in his discussion, in which a mass ligation was considered advisable.

As to the incidence of contralateral or ipsilateral spread, we have had only one case of what might be considered a direct extension from a right upper lobe abscess into the right

middle lobe. At the time of resection of the right upper lobe abscess this was recognized, but it was decided to take a chance on this process being reversible, and preserve the middle lobe. It was necessary at a later date to go in and resect the middle lobe. There have been no contralateral spreads.

I agree with Dr. Grace that the value of antibiotics is very great in the preoperative preparation of these patients for surgery, and in the prophylaxis of the development of pneumonitis, cellulitis, and empyema postoperatively.

Certainly in any case in which carcinoma is suspected from the patient's history or the findings, a thoracotomy should be done to determine the precise nature of the lesion.

DR. E. M. KENT, Pittsburgh, Pa.—Contralateral spread is a problem. We had two additional cases which responded to antibiotic therapy. We have not used the face-down position. We have had to use bronchoscopy, as indicated, during operation and at the close of the operation. I think that possibly the face down position is the ultimate answer to most all of these spreads, whether they are tuberculous or nontuberculous cases.

It was mentioned that carcinoma frequently is responsible for chronic or chronic-appearing lung abscesses, and that is quite true. None of those cases have been included in this group presented today, but it is so important a consideration in the diagnosis of that disease that very often resection is necessarily elected because of the uncertainty in patients of the carcinoma age group, and it has been mentioned earlier, I think, by one of the men, that about one-third of the cases they resected on that assumption proved, after the removal of the lung, to be on a carcinomatous basis.

# CLOSED INTRAPLEURAL PNEUMONOLYSIS

## An Analysis of 1,000 Consecutive Operations

J. Claude Day, M.D., and (by invitation) Paul T. Chapman, M.D., and E. J. O'Brien, M.D.
Detroit, Mich.

THAT pneumonolysis is essential to a properly balanced program of collapse therapy is axiomatic. Its judicious and skilled application in as many pneumothoraces with restraining adhesions as is consistent with safety is desirable. Its complete omission or infrequent use may be as harmful as its too ambitious application. We are not in accord with a current tendency to regard it as a procedure which should be employed universally in every pneumothorax with adhesions, and, conversely, we feel that the failure to utilize it to its fullest capacity when the indication is clear is inexcusable.

It is the purpose of this paper to study the effects of pneumonolysis upon the course of pneumothorax; to examine the factors thought to be responsible for the significant complications; to report the present status of the patients after a follow-up period of from six months to seven years, and to attempt an evaluation of the ultimate fate of the pneumothorax in relation to pneumonolysis.

It has been our feeling that many of the reports dealing with the results of pneumonolysis have been limited too strictly to the immediate postoperative period. The failure to recognize that the eventual fate of the pneumothorax may be and often is inseparably linked with the influence which the pneumonolysis has exerted on its course, has mitigated against an accurate evaluation of either. Such preoccupation with the operation itself and failure to accept the occurrence of many late complications as directly related to the operation are not consistent.

The early recognition of the importance of pleural adhesions in preventing effective pneumothorax led to attempts to devise methods for freeing them. Friedrich, in 1908, first divided adhesions through an incision into the pleural cavity. This method of open pneumonolysis was used much later with considerable success by Anderson and Alexander,[1] O'Brien,[2] and Carter.[3] Although before the perfection of intrapleural pneumonolysis it was thought to have a respectable place in the surgical treatment of tuberculosis, its many obvious disadvantages soon eliminated it almost completely. It is mentioned here only to condemn it. Its recent revival in certain isolated clinics is to be deplored.

From the Department of Thoracic Surgery, Herman Kiefer Hospital, Detroit, and the Wm. H. Maybury Sanatorium, Northville, Mich.
Read at the Twenty-Seventh Annual Meeting of the American Association for Thoracic Surgery, St. Louis, Mo., May 28, 29, and 30, 1947.

The operation for the severance of adhesions under endoscopic guidance was devised by Hans Jacobaeus[4] in 1913. The method employed by him, modified by Unverricht,[5] and later improved by the introduction of newer types of telescopes, electrosurgical cutting instruments, and various accesesory equipment, is still the most widely used. Ralph Matson[6] popularized the operation in this country and was the first to discard the galvanocautery for electrosurgery. He devised electrodes which were described by Moore[7] as the most useful to be had for intrathoracic work. Moore[7] has used the electrosurgical method exclusively.

Davidson[8] and Cutler[9] in this country and Chandler[10] in England were the first to devise an instrument combining the telescope and cutting electrode adaptable to use through a single portal of entry. The O'Brien modification of the Davidson-Cutler thoracoscope has gained wide popularity in recent years and was used by us exclusively in this series. Though many advantages are cited by the proponents of both methods, it is likely that the results of experienced operators will not be significantly different.

Because of lack of uniformity in selection of patients for operation and in definition of complications, this procedure lends itself poorly to analysis, and comparison of statistics is difficult.

Matson[6] reported that in 152, or 61 per cent, of 249 patients the operation was technically and clinically successful; an additional nineteen (7.6 per cent) were clinically successful despite incomplete operation; in two who died operation had been technically successful. Forty-one, or 16.5 per cent, developed pure tuberculous empyema.

Jacobaeus had technical success in 80.7 per cent of 150 patients and early clinical success in 66 per cent. He reported eleven, or 7.4 per cent, of empyema deaths among his, Gravens' and Holmboe's 148 pneumonolysis cases.

In 1934 Moore[7] reported 75.5 per cent clinical success in 1,850 collected cases. The incidence of tuberculous empyema in 2,043 collected cases was only 2.2 per cent and that of mixed infection empyema 1.8 per cent.

Drash[13] in 1938, using the Davidson-Cutler thoracoscope, reported the occurrence of only 2.6 per cent tuberculous empyemas and no mixed empyemas in his series of 251 pneumonolyses.

Goorwitch[14] in 1944 reported a collected series including his own patients and comprising 5,114 patients. The incidence of pure tuberculous empyema ranged from 0 to 10 per cent (in one instance 24 per cent); that of pyogenic empyema from 0 to 6 per cent and mixed tuberculous empyema 0 to 5 per cent. The incidence of clinical success ranged from 44 per cent to 96 per cent and averaged 73 per cent.

Edwards, Penman, and Logan[15] in 1944 report that 133, or 66.4 per cent, of 200 patients with unilateral pneumothoraces with pneumonolysis survived five years and that seventy-one (86.5 per cent) of those with satisfactory collapse obtained at operation survived five years and fifty-six were well and working after six years. Tuberculous empyema was observed nine times and mixed empyema nine times but it accounted for only 18 per cent of the deaths.

H. A. Jones[16] in 1945 in a review of 509 consecutive closed intrapleural pneumonolyses over a seven-year period reports an incidence of only 1.5 per

cent pure tuberculous empyemas, 0.4 per cent staphylococcus empyemas and 0.6 per cent mixed infection empyemas.

## CLINICAL MATERIAL

During the period from 1940 to 1946 inclusive, 1,000 consecutive closed intrapleural pneumonolyses were performed upon 923 patients at the Herman Kiefer Hospital, Detroit, and the William H. Maybury Sanatorium, Northville Mich.

The distribution as to sex shows practically equal numbers in the white group and a slight preponderance of female patients among the Negro group. The ratio between the number of white and Negro patients is approximately five white to one Negro patient. The over-all fatality rate is 18 per cent. The fatality rate for the Negro group is 26.4 per cent and the white 16.3 per cent. In seventy-seven bilateral pneumonolyses there were sixteen deaths, or a fatality rate of 20.8 per cent.

The discussion of indications for pneumothorax does not fall within the scope of this paper. The indications for its use have been dealt with at length by Rafferty.[17] In this series there are no patients who were classified as having minimal disease, since it is our policy to treat such lesions with bed rest usually supplemented by phrenic nerve crushing. Also in many moderately advanced lesions which are noncavernous or in which cavities are small and thin-walled, we prefer an initial trial of a similar program. Consequently all patients have at least moderately advanced and the great majority have far advanced disease.

TABLE I. CLOSED INTRAPLEURAL PNEUMONOLYSIS: ANALYSIS OF 1,000 OPERATIONS EMPLOYED IN THE TREATMENT OF 923 PATIENTS (1940-1946)

| RACE AND SEX | NO. PATIENTS | DEATHS | FATALITY RATE (%) |
|---|---|---|---|
| White | | | |
| Male | 389 | 66 | |
| Female | 379 | 59 | 16.3 |
| Negro | | | |
| Male | 65 | 19 | |
| Female | 90 | 22 | 26.4 |
| Total | 923 | 166 | 18.0 |
| BILATERAL PNEUMONOLYSIS | | | |
| White | 68 | 14 | |
| Negro | 9 | 2 | |
| Total | 77 | 16 | 20.8 |

Since the immediate success of a pneumothorax would seem to be related most closely to the diseased lung which it collapses, we have found it convenient to classify the disease by extent, presence of cavity, and type of infiltration existing in the lung, and for the most part have ignored the standard classification of pulmonary tuberculosis.

## TYPE OF DISEASE

The type of disease for which pneumothorax was initiated is shown in Table II. The presence of thirty-seven lungs with pneumonic disease is ac-

TABLE II. TYPE AND EXTENT OF DISEASE FOR WHICH PNEUMOTHORAX WAS INSTITUTED—1,000 LUNGS

| PNEUMOTHORAX | NO. | PER CENT |
|---|---|---|
| *Type* | | |
| Exudative | 418 | 41.8 |
| Mixed | 250 | 25.0 |
| Productive | 295 | 29.5 |
| Pneumonic | 37 | 3.7 |
| Total | 1,000 | 100.0 |
| *Extent* | | |
| ⅓ of lung | 144 | 14.4 |
| ½ of lung | 411 | 41.1 |
| Over ½ of lung | 445 | 44.5 |
| Total | 1,000 | 100.0 |
| *Cavity* | | |
| None | 142 | 14.2 |
| Under 2 cm. | 396 | 39.6 |
| 2 to 4 cm. | 340 | 34.0 |
| Over 4 cm. | 122 | 12.2 |
| Total | 1,000 | 100.0 |

counted for on the basis of urgency dictated by pulmonary hemorrhage or progressive disease. The indication for pneumothorax in this type of disease is admittedly very limited.

With regard to extent of disease it should be noted that one-half of the lung or over is involved in 86.6 per cent.

Cavities were present in 85.8 per cent of the lungs that were collapsed. Of these, 12.2 per cent were over 4 cm. in diameter, 34 per cent 2 cm. to 4 cm., 29.6 per cent under 2 cm.

In addition, there was contralateral disease in 80.6 per cent. Of the contralateral lungs there were 36.9 per cent with infiltration but no cavity, 19.6 per cent with cavity, 16.3 per cent with contralateral pneumothorax, and 0.6 per cent with thoracoplasty at the time of pneumonolysis.

## POSTOPERATIVE COMPLICATIONS

The exercise of reasonable care at the time of operation should avert most of the dramatic complications which may occasionally occur. Experience alone is the best safeguard against too vigorous or too cowardly use of the cautery.

TABLE III. PLEURAL COMPLICATIONS, IMMEDIATE POSTOPERATIVE PERIOD

| COMPLICATIONS | NO. | PER CENT |
|---|---|---|
| None | 595 | 59.5 |
| Fluid, serous | | |
| Minimal, not aspirated | 276 | 27.6 |
| Large amount, aspirated | 65 | 6.5 |
| Fluid, hemorrhagic | 46 | 4.6 |
| Empyema | | |
| Tuberculous | 5 | 0.5 |
| Mixed | 4 | 0.4 |
| Traumatic pneumothorax | 8 | 0.8 |
| Loss of space | 1 | 0.1 |
| Total | 1,000 | 100.0 |

Careful closure of the wound and prompt adjustment of intrapleural pressures while the patient is still on the table should obviate troublesome subcutaneous emphysema, reduce cough and dyspnea to a minimum, and make effusion less likely.

The most common complication was simple fluid which developed in 276 instances or 27.6 per cent. This fluid was a trace in the costophrenic angle and in no instance rose as high as the dome of the diaphragm. In sixty-five instances there was sufficient fluid to warrant aspiration at least once and in some aspiration needed to be repeated often and continued intermittently until the lung was re-expanded. There were forty-six, or 4.6 per cent, of the operations which were followed by hemorrhagic fluid. In three instances the bloody fluid was so great in amount that transfusion was thought necessary. In one of these the chest was opened but bleeding was very minimal. A fourth patient, the second on whom thoracotomy was performed, perhaps unnecessarily, showed no active bleeding point. In both instances of bleeding where thoracotomy was done the fault was discovered to be in a change which the manufacturer had made in the cautery tip without our knowledge. All other hemorrhagic fluid was inconsequential.

Tuberculous empyema developed in five instances, or 0.5 per cent, and, in addition, in four others, or 0.4 per cent, there was tuberculous empyema with secondary organisms. Traumatic pneumothorax occurred eight times, or in 0.8 per cent. Two of these were fatal and will be described in more detail later. One space was lost. The immediate complications were all those which occurred any time within two months of the operation.

TABLE IV. EFFECT OF OPERATIVE SUCCESS UPON PNEUMOTHORAX

| OPERATION | PNEUMOTHORAX IMMEDIATELY ABANDONED | PNEUMOTHORAX CONTINUED TO DEATH | LATER ABONDONED | | EFFECTUAL PNEUMOTHORAX | TOTAL |
|---|---|---|---|---|---|---|
| | | | PLEURAL COMPLICATIONS | OTHER COMPLICATIONS | | |
| Thoracoscopy only | 33 | 4 | 10 | 7 | 25 | 79 |
| Partial pneumonolysis | 21 | 20 | 83 | 87 | 212 | 423 |
| Complete pneumonolysis | 11 | 31 | 71 | 70 | 315 | 498 |
| Total | 65 | 55 | 164 | 164* | 552† | 1,000 |

*1. Ineffectual Pneumothorax—Late.
2. Neglect by Patient.
3. Progression of Disease Elsewhere.
4. Inadequate Respiratory Reserve.

†120 Expanded—Therapeutically Sufficient.

Of the 1,000 lungs subjected to surgery, there were thirty-four two-stage operations and one three-stage procedure. The multiple procedures are considered as one operation in this analysis. As is shown in Table IV there were seventy-nine instances, or 7.9 per cent, where only thoracoscopy was performed. In this group the usual cause for failure was extensive adhesions. Seventy-one of the pleural spaces displayed adhesions which were extensively confluent or in which definite pleural symphysis was evident. In five other instances the pleural surfaces were inflamed and edematous, tubercles were noted, or the patient was too dyspneic to tolerate the procedure.

Partial pneumonolysis was performed in 423 or 42.3 per cent. Operations designated in this manner indicate that all adhesions were cut except those in which a small area of symphysis coexisted. Most often these areas of symphysis were located posteriorly in the costovertebral gutter or in the cupola or mediastinum. When adhesions were confluent with the mediastinal structures except for a lateral free border, the latter were usually cut to within 2 cm. of the danger area. In case of doubt, when the vessels could not be well visualized, we cautiously abstained from severing adhesions in this area. In 309 instances the adhesions were extensive confluent bands, sometimes with only one free edge. Thirty-five showed at least a partial symphysis. In fifty-nine instances the adhesions were multiple discrete and in twenty instances minimal. In these latter two groups the accidental location of short adhesions in the region of the vessels was the only reason why only part of the adhesions could be cut.

Complete pneumonolysis, meaning the severance of all adhesions to the diseased lobe or lobes, was accomplished in 49.8 per cent of the cases. There were no cases of actual symphysis although eighty-five instances of extensive confluent adhesions were noted. The remainder were multiple discrete in 225 instances and minimal or solitary in 188 cases.

There were sixty-five pneumothoraces abandoned immediately after operation. Thirty-three of these followed thoracoscopy only, and twenty-one, or approximately one-third, followed partial pneumonolysis. Of the remaining eleven where pneumonolysis was complete, dyspnea, inflammation of the pleura, and tension cavity were responsible for the decision to expand the lung. One space was accidentally lost.

Effectual pneumothorax was the ultimate result in only twenty-five, or 31.6 per cent, where thoracoscopy only was done; in 212, or 50.1 per cent, of the partial pneumonolyses; and in 315, or 63.2 per cent, in those with complete pneumonolysis.

The reasons for abandonment of pneumothorax immediately following pneumonolysis were primarily related to ineffectiveness of collapse rather than to new pleural complications. Significant pleural complications were present in only ten of sixty-five cases. One was lost through disruption of the wound; two by traumatic pneumothorax; one from tuberculous empyema; one from hemorrhage and five from the development of large amounts of serous fluid.

To explain the reasons for failure this point has been studied in relation to type of disease extent of disease, and cavity size.

TABLE V. FATE OF PNEUMOTHRAX AFTER PNEUMONOLYSIS

| | PNEUMOTHORAX IMMEDIATELY ABANDONED | | MAINTAINED TO DEATH | |
|---|---|---|---|---|
| TYPE OF DISEASE | NO. | PER CENT | NO. | PER CENT |
| Exudative | 30 | 7.2 | 22 | 5.3 |
| Mixed | 17 | 6.8 | 13 | 5.2 |
| Productive | 15 | 5.1 | 18 | 6.1 |
| Pneumonic | 3 | 8.2 | 2 | 5.4 |
| Total | 65 | 6.5 | 55 | 5.5 |

Table V indicates that the more active acute forms of disease are likely to lead to expansion early. The pneumonic group is so small as to be insignificant statistically.

TABLE VI. FATE OF PNEUMOTHORAX AFTER PNEUMONOLYSIS

| EXTENT | PNEUMOTHORAX IMMEDIATELY ABANDONED | | MAINTAINED TO DEATH | |
|---|---|---|---|---|
| | NO. | PER CENT | NO. | PER CENT |
| ⅓ of lung | 4 | 2.8 | 0 | 0.0 |
| ½ of lung | 28 | 6.8 | 18 | 4.4 |
| Over ½ of lung | 33 | 7.4 | 37 | 8.3 |
| Total | 65 | 6.5 | 55 | 5.5 |

Considered from the angle of extent of disease, as in Table VI, we find, as would be expected, that early abandonment shows a more or less direct relation to this factor. The more extensive the disease the greater is the proportion of cases given up. In fact, the proportion of cases with involvement of over one-half a lung is more than two to one as compared to those who had lesions of one-third of the lung.

The most striking relationship is shown in Table VII where the existence of large cavity leads to failure approximately twice as frequently as in any other cavity group. Furthermore, it should be mentioned that the existence of cavity of any size doubles the chance of failure.

TABLE VII. FATE OF PNEUMOTHORAX AFTER PNEUMONOLYSIS

| CAVITY | PNEUMOTHORAX IMMEDIATELY ABANDONED | | MAINTAINED TO DEATH | |
|---|---|---|---|---|
| | NO. | PER CENT | NO. | PER CENT |
| None | 4 | 2.8 | 5 | 3.5 |
| Under 2 cm. | 24 | 6.1 | 20 | 5.1 |
| 2 to 4 cm. | 23 | 6.8 | 16 | 4.7 |
| Over 4 cm. | 14 | 11.5 | 14 | 11.5 |
| Total | 65 | 6.5 | 55 | 5.5 |

One of the most confusing issues in the reporting of the complications of pneumonolysis is that centered around the problem of empyema, admittedly the most serious of pleural complications. The definitions of tuberculous empyema range from the liberal one of Woodruff,[18] who includes all turbid fluids in the presence of pulmonary tuberculosis and any fluid containing tubercle bacilli on direct smear, and that of Eglee and Wylie,[19] who include only thick purulent fluid for which treatment is necessary. An even more strict conception is that suggested by DeCecio and Potter,[20] who include not only the presence of frank pus but also a clinical picture of rapid formation of exudate accompanied by prolonged fever and constitutional decline as the chronicity of the empyema is established. We have chosen an intermediate position and are in essential agreement with Goorwitch,[14] who interprets purulent fluid as an opaque fluid which is to be distinguished from serous fluid, described as clear, cloudy, turbid, translucent, or opalescent. Our definition of tuberculous empyema

has been liberalized to include turbid or cloudy fluid which has required several aspirations and has persisted over a period of several weeks whether or not accompanied by fever or other constitutional symptoms. All such fluids were included which appeared at any time during the entire duration of the pneumothorax.

The coexistence of bronchopleural fistula with mixed empyema was proved to be present in the majority of instances and was assumed to be present in the remaining ones. Since obviously it also occurred in the traumatic pneumothoraces and was perhaps, at one time or another, present in some of the tuberculous empyemas, its total incidence is not clear and it does not appear alone in the statistics.

Persistent fluid is defined simply as serous fluid which occurred late in the course of pneumothorax following pneumonolysis which was consistently noted on fluoroscopic or roentgenographic examination or was aspirated on several occasions. It was most often unattended by constitutional symptoms. Frequently it was too small in amount to require aspiration.

It will be noted by referring to Table VIII that in 683, or 68.3 per cent, of pneumonolyses there were no late pleural complications. The inclusion of sixty-five immediately abandoned pneumothoraces and five immediate deaths in this figure is self-explanatory.

Traumatic pneumothorax occurred in five, or 0.5 per cent, and was responsible for death in two instances. Obliterative pleuritis with late loss of space resulted in sixty-three, or 6.3 per cent.

The incidence of tuberculous empyema occurring late is 3.5 per cent; that of mixed infection empyema is 1.5 per cent. The over-all incidence of empyema is 5.3 per cent since six instances of late empyema are also recorded as having their inception in the early postoperative period.

### RELATION OF EARLY TO LATE COMPLICATIONS

The late complications listed in Table VIII obviously bear some relationship to those complications which occurred in the two-month postoperative period. For example, when late persistent fluid is considered we find that 35.4 per cent of those who had a large amount of fluid early show late persistent fluid; 26.4 per cent of those with a trace of fluid early had late persistent fluid; 23.9 per cent of those with hemorrhagic fluid early had late persistent fluid;

TABLE VIII. LATE PLEURAL COMPLICATIONS

| COMPLICATION | NO. | PER CENT |
|---|---|---|
| None | 683* | 68.3 |
| Persistent fluid | 199 | 19.9 |
| Empyema | | |
| Tuberculous | 35 | 3.5 |
| Mixed | 15 | 1.5 |
| Traumatic pneumothrax | 5 | 0.5 |
| Obliterative pleuritis | 63 | 6.3 |
| Total | 1,000 | 100.0 |

*Including five immediate operative deaths and sixty-five immediately abandoned.

and only 16.8 per cent of those with no fluid early develop persistent late fluid. Empyema, either tuberculous or mixed, persists in 66.6 per cent of those in which it was present in the early period. It develops in 18.5 per cent of the spaces where large amounts of fluid were present early; in 6.2 per cent of those with a trace of fluid, and in only 2.4 per cent of those with either no fluid or hemorrhagic fluid early. Late obliterative pleuritis is most marked in the early empyema group, being 11.1 per cent, and, in the patients with large effusions, 10.8 per cent. If hemorrhagic fluid, trace of fluid, or no fluid is present, then the rate of obliterative pleuritis is from 5.4 per cent to 5.9 per cent.

### CAUSES OF DEATH

Of the five immediate deaths, one occurred the day of operation. This man had a contralateral pneumothorax in which there developed a tension pneumothorax. Furthermore he was a poorly controlled diabetic. The operation was on a minimal type of adhesion. A second death attributed to traumatic pneumothorax occurred on the fourteenth day in a Negro woman who had extensive bilateral disease. The three other deaths all occurred in individuals who had extensive bilateral acute disease. These individuals were febrile and had evidence of remote extension such as laryngitis and enteritis.

TABLE IX. PNEUMONOLYSIS—1,000 OPERATIONS ON 923 PATIENTS

| CAUSES OF DEATH | NO. | |
|---|---|---|
| Immediate deaths | | |
| Traumatic pneumothorax (contralateral lung) (24 hrs.) | 1 | |
| Traumatic pneumothorax (fourteenth day) | 1 | |
| Extension of tuberculosis (within 2 months) | 3 | |
| Total | | 5 |
| Late deaths | | |
| Traumatic pneumothorax | 3 | |
| Empyema—tuberculous 2 | 7 | |
| Mixed 5 | | |
| Extra pulmonary tuberculosis | 8 | |
| Pulmonary hemorrhage | 4 | |
| Extension of pulmonary tuberculosis | 129 | |
| Following thoracoplasty | 4 | |
| Chronic cor pulmonale | 3 | |
| Nontuberculous | 3 | |
| Total | | 161 |
| Total deaths | | 166 |

The deaths occurring late could be attributed directly to empyema in seven instances, and to traumatic pneumothorax in three others. These deaths we feel bear close relation to the unwise use of pneumothorax and pneumonolysis. Of the remainder, extension of pulmonary disease is by far the most important cause of death.

### PNUEMOTHORAX LATER ABANDONED

Of 164 who lost their pneumothoraces late because of pleural complications, 30, or 18.3 per cent, have since died.

Of the 164 patients who lost their pneumothoraces through their own neglect or because of inadequate respiratory reserve or extension of disease else-

TABLE X. PNEUMOTHORAX LATER ABANDONED

| TYPE OF DISEASE | PLEURAL COMPLICATIONS | | OTHER COMPLICATIONS | |
|---|---|---|---|---|
| | NO. | % TOTAL | NO. | % TOTAL |
| Exudative | 74 | 17.7 | 69 | 16.5 |
| Mixed | 33 | 13.2 | 39 | 15.6 |
| Productive | 45 | 15.2 | 51 | 17.3 |
| Pneumonic | 12 | 32.4 | 5 | 13.5 |
| Total | 164 | 16.4 | 164 | 16.4 |

where or who were re-expanded late because of inadequate collapse, seventy-five, or 45.7 per cent, are now dead. Forty-one of the re-expanded group, either early or late, were subjected to thoracoplasty, thirty-seven primarily for the uncontrolled pulmonary lesion and four for obliteration of the empyema space.

TABLE XI. EFFECTUAL PNEUMOTHORAX

| TYPE OF DISEASE | STILL MAINTAINED | | REEXPANDED | |
|---|---|---|---|---|
| | NO. | PER CENT | NO. | PER CENT |
| Exudative | 177 | 42.3 | 46 | 11.0 |
| Mixed | 120 | 48.0 | 28 | 11.2 |
| Productive | 126 | 42.7 | 40 | 13.6 |
| Pneumonic | 9 | 24.3 | 6 | 16.2 |
| Total | 432 | 43.2 | 120 | 12.0 |

One hundred twenty pneumothoraces have been re-expanded as therapeutically sufficient. Two in this group are now dead and four are still in the hospital. There are 432 patients with effectual pneumothorax of whom seventy are in the hospital because of the recency of institution of their treatment.

TABLE XII. PRESENT STATUS OF 923 PATIENTS SIX MONTHS TO SEVEN YEARS AFTER PNEUMONOLYSIS

| TYPE OF DISEASE | LIVING AT HOME | | IN HOSPITAL | | DEAD | | UNKNOWN | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | NO. | PER CENT | NO. | PER CENT | NO. | PER CENT | NO. | PER CENT | |
| Exudative | 203 | 52.2 | 71 | 18.2 | 77 | 19.8 | 38 | 9.8 | 389 |
| Mixed | 121 | 52.2 | 46 | 19.8 | 42 | 18.1 | 23 | 9.9 | 232 |
| Productive | 164 | 61.9 | 33 | 12.4 | 41 | 15.5 | 27 | 10.2 | 265 |
| Pneumonic | 23 | 62.2 | 3 | 8.1 | 6 | 16.2 | 5 | 13.5 | 37 |
| Total | 511 | 55.4 | 153 | 16.6 | 166 | 18.0 | 93 | 10.0 | 923 |

Of 923 patients recent data are available on 830. In 483 the disease is arrested and in 181 it is still active. Five-sixths of the active cases are still in the hospital and though in many the disease is under control, it cannot be considered arrested.

TABLE XIII. PRESENT STATUS OF TUBERCULOSIS IN 923 PATIENTS SIX MONTHS TO SEVEN YEARS AFTER PNEUMONOLYSIS

| TYPE OF DISEASE | ARRESTED | | ACTIVE | |
|---|---|---|---|---|
| | NO. | PER CENT | NO. | PER CENT |
| Exudative | 198 | 50.9 | 76 | 19.5 |
| Mixed | 114 | 49.1 | 53 | 22.8 |
| Productive | 149 | 56.2 | 48 | 18.1 |
| Pneumonic | 22 | 59.5 | 4 | 10.8 |
| Total | 483 | 52.3 | 181 | 19.6 |

## DISCUSSION

Ideally, all pneumothoraces for which the original indications are sound should be converted to pneumothoraces entirely free from restraining adhesions if such a course is consistent with safety. Since for obvious reasons this is impossible of attainment, the choice between continuation of an ineffective pneumothorax and immediate abandonment in favor of some other measure often must be made. This decision will hinge mainly upon the appraisal of the pneumothorax as regards the possibility of severing adhesions. It is well known that the roentgenogram can be misleading and that thoracoscopic examination may be the only means of settling the issue. It is possible, however, to screen out certain cases from the roentgenographic survey alone. In this category can be placed pneumothoraces with widely adherent portions of the lung where separation is obviously impossible. Even in situations where advanced disease in the contralateral lung make impossible the use of thoracoplasty as an alternate procedure, the hazards are so great as to contraindicate pneumonolysis and in many instances even the introduction of the thoracoscope.

When there is reasonable doubt as to whether or not the adhesions are suitable for severing with the cautery, thoracoscopy should be done. If on inspection of the pleural cavity the adhesions are found to be simple bands, cords, or more complex arrangements of adhesions which present completely free borders on all sides and which do not attach dangerously near to important vascular structures, the indication is clear. If, on the other hand, inspection reveals a complex arrangement of adhesions which present only one or more free edges and then become confluent with the parietes, especially in the cupola or mediastinum, in such a fashion as to render complete severance unfeasible if not impossible, it is thought to be unwise to attempt cauterization of those portions available for section. In the range between two extremes of minimal or solitary adhesions and the situation related above, so much depends on the experience of the operator in determining the suitability of adhesions for section that absolute contraindications cannot be laid down. In general, however, it can be said that greater conservatism has run parallel with wider experience.

Obviously, however the suitability for operation cannot be decided solely upon the availability of adhesions for sectioning. Such factors as type of disease, extent of disease, cavity size and position are of paramount importance. Except for pneumonic disease in which perhaps the wisdom of the use of pneumothorax is open to question, and in certain extensive exudative lesions in which there is not actual lobar consolidation, there is no definite evidence to show any considerable difference in response following operation. It seems logical to conclude that following the initial phase of the disease when a higher incidence of pleural complications is to be anticipated from exudative and pneumonic disease there is a rapid conversion to a productive type of disease in which greater uniformity of response may be anticipated as regards pleural complications and eventual behavior of the lesion itself.

It is now well recognized and further confirmation is offered by the results of this study that a high incidence of pleural complications is to be anticipated

in lesions with large cavities or multiple cavities of aggregate diameter exceeding 4 cm. The large cavity often fails to close even with free pneumothorax because of poor bronchial communication. Often even if such a lesion is apparently controlled, parenchymal damage is so extensive as to indicate permanent collapse or at least to make expansion hazardous, if possible. For these reasons it is questionable if pneumonolysis is ever justifiable in lesions with large cavity or cavities. When such cavities are definitely peripheral in position and are supported by dense adhesions it is considered an absolute contraindication to pneumonolysis.

### CONTRAINDICATIONS

Briefly summarizing the foregoing discussion and adding certain generally accepted contraindications, the following are suggested as instances in which pneumonolysis should not be done.

1. In the presence of tuberculous empyema.
2. In the presence of acute febrile pleurisy with effusion.
3. When extensive progressive parenchymal disease is present.
4. When dense adhesions are present over large, peripherally placed cavities.
5. When pleural symphysis or extensive confluent adhesions make technical success very unlikely. (We do not believe that so-called enucleation of broadly adherent portions of lung by extrapleural dissection is a justifiable procedure.)

The following contraindications we believe to be relative because of the availability of thoracoplasty or other surgical measures as alternative procedures:

6. Unilateral apical fibrocavernous disease with extensive but apparently severable adhesions.
7. Wherever extensive parenchymal damage indicates the need for permanent collapse.

### TECHNIQUE

The single cannula O'Brien Model (modification of original Cutler thoracoscope) with McCarthy foroblique telescope is used. The cannula is large enough to accommodate the telescope with a detachable cutting electrode. If the site of entrance is correct, it is nearly always possible to sever all the adhesions at one operation. High frequency spark gap current which can be switched from scalpel to cautery readily if bleeding occurs is always used. The tip of the cautery is in sight at all times except when it may be passed beyond an adhesion. The light is far enough removed from the lens to allow easy transillumination of adhesions. A side view or right angle telescope is available but rarely used.

Entrance into the chest is made by an incision parallel to the rib in whatever interspace is suitable (usually the third or fourth interspace in midaxillary line). The incision is usually 3 to 5 cm. in length and is carried through skin and subcutaneous tissues to the extracostal muscles. These muscles and the intercostals are split by blunt dissection and with the aid of small retractors

the pleura is exposed. The pleura is punctured with the tip of a fine forceps which is held open until the cannula can be inserted through the opening. When the endopleural procedure is completed and the cannula removed, the intercostal muscles are carefully closed with a single figure-of-eight suture of No. 0 catgut or silk. The intrapleural pressures are always readjusted to the usual pressure by the removal of whatever amount of air is necessary to accomplish this. The usual case requires the removal of about 500 c.c. to 800 c.c. A small bandage is applied to the wound but no pressure binder is necessary. The patient is fluoroscoped daily. An effort is made to prevent the patient from lying on the side of operation for a week to avoid the possible formation of new adhesions.

The advantages seen for this instrument are as follows:

1. The ease of handling this simple compact unit makes a very tedious operation less fatiguing to the surgeon and consequently less hazardous to the patient.

2. The combining of the cutting electrode and telescope into one unit makes for greater accuracy of manipulation.

3. The high frequency electrosurgical unit of the spark gap type (Bovie electrosurgical unit) provides a very satisfactory cutting current allowing an adequate admixture of coagulating effect to the cutting blades, thus providing good hemostasis and still permitting ready and concise severance of adhesions. Postoperative edema and excessive eschar or coagulum on the cut stumps are minimal and, we believe, less than that seen when the galvanocautery is used.

A special ball type of electrode provides coagulation which is effective in controlling all but the serious hemorrhage which may occur as a result of accidental wounding of large vessels.

## CONCLUSIONS

Pneumonolysis when employed by experienced operators in accordance with generally accepted indications may be performed without appreciable hazard to the patient and with the expectation that serious complications will be minimal. Its use in pneumothoraces which have been initiated to control small lesions and in which a few readily accessible adhesions are present should be attended by no serious complications. As the complexity of the adhesions increase, paralleling for the most part the increase in extent of the lesion, serious pleural complications must be anticipated with increasing frequency. The increase in incidence of complications to be anticipated under such conditions is the direct result of the necessity for prolonged tedious cauterization of difficult complex adhesion patterns. It is quite likely that the transection of small tuberculous foci or prolongations of lung into adhesions or within the adhesion itself is responsible for many pleural infections of tuberculous origin. In the more complex situations careful assessment must be made as regards the suitability of the lesion for other surgical procedures especially thoracoplasty. The latter is always preferable in unilateral disease when there is reason to expect persistent fluid and eventual empyema as a result of an extensive procedure. If, because of uncontrolled contralateral disease, unfavorable location of the lesion, or poor general condition, thoracoplasty is not feasible, extensive pneumonolysis may

offer the only chance of recovery and may be justified even in the face of almost certain empyema. It is in this group of patients that the incidence of serious complications is likely to be high. Consequently a careful appraisal must be made in order to avoid performing needless operations which may result in increased morbidity and perhaps even in fatality which may be far out of proportion to the occasional therapeutic success. Indeed in many of these patients it is far better to abandon the pneumothorax and to allow them to live longer and without the discomfort and threat to life attendant upon pleural infection.

## SUMMARY

1. Of 1,000 lungs treated with artificial pneumothorax in 923 patients for which pneumonolysis was attempted, the operation was complete in 49.8 per cent; partial in 42.3 per cent; and a failure in 19 per cent.

2. Pleural complications occurred more often and were more serious if partial pneumonolysis was done, less so if it were complete, and least in thoracoscopy.

3. Early postoperative complications were most frequent in face of extensive disease and least in minimal involvement. Early complications were most frequent if cavity was present and increased markedly with increase in cavity size. Also the more acute forms of pneumonic and exudative tuberculosis were associated with the highest proportion of complications.

4. Abandonment of pneumothorax in the early postoperative period was most frequently dictated by the condition of the collapse (success of pneumonolysis) and by the extent and character of the underlying disease.

5. Late complications tend to follow early ones, i.e., those with no complications develop proportionately the least in the late period. As each group of immediate complications increases in severity it tends to be followed proportionately by more frequent and severe late complications.

6. Late complications outnumber those in the early group and are proportionately more severe. These lead in one way or another to premature loss of pneumothorax in 32.8 per cent of the total.

7. Successful late pneumothorax is maintained in 432, or 43.2 per cent, of the group, and 120 additional, or 12.0 per cent, have been successful and are now re-expanded.

8. Five deaths occurred in the immediate postoperative period—two from the operation and three from extensive active tuberculosis.

9. One hundred sixty-one patients died later. At least ten of these deaths are thought to be due to complications more or less directly attributable to the operation.

10. Contraindications to pneumonolysis are discussed.

11. The technique of the single cannula method is described.

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## DISCUSSION

DR. EDWARD S. WELLES, Saranac Lake, N. Y.—I am a little confused by the statistics, especially on the percentage of deaths.

I am not accustomed to associating death with pneumonolysis, and am afraid that this paper, if the figures are looked at lightly, is going to give the operation a black eye, not through the operations or the technique of the Detroit group, but through the analyses of their statistics, which I think are completely wrong.

On the first slide there was a 20 per cent death rate following pneumonolysis. A total of 161 died, so the mortality of pneumonolysis is 16 per cent.

That is ridiculous. I do not doubt that these people died, but they did not die from pneumonolysis, and there are several other factors that enter into this death rate. Undoubtedly a good many of these patients were dreadfully sick when pneumothorax was started, and might have died even if they had not had pneumothorax. Possibly some of them who are described as having exudative acute disease might much better have been left alone until they quieted down, and probably a good many of them might better have been given primary thoracoplasty and not pneumothorax at all. It was not the pneumonolysis that killed them.

Maybe the five immediate operative deaths come in there, and maybe some of the later ones could be attributed to the operation, but I cannot believe such figures. An explanation ought to be made in the paper itself when it is published, because I have been doing pneumonolysis for 21 years, and am afraid that people reading this paper, who are not here to hear this discussion will get the wrong impression. I would hate to have them frightened away from as harmless an operation as pneumonolysis by thinking of a 16 or 20 per cent death rate following the operation.

One other little point: one of the contraindications to the operation, I think this is straight, but I am not sure, is peripherally placed cavities. That I do not understand, either,

because in a great many of the pneumothorax cases which require pneumonolysis there are peripheral cavities. As soon as the bands are cut and the cavities are released, they are closed, and I do not understand this as a contraindication.

DR. JULIAN A. MOORE, Asheville, N. C.—I agree with Dr. Welles. I thought that mortality rate of 16 per cent was tremendous. If I felt that my mortality were going to be 16 per cent with this operation, I would have abandoned it long ago.

It seems to me unfair to the procedure to give the late mortality rate of tuberculosis and not of the operation. The actual mortality from the operation, both directly and indirectly, was fifteen patients out of 1,000, which is 1.5 per cent. This corresponds closely with what has been reported in the literature before.

Now the operation was designed for one purpose, and that was to convert an unsatisfactory pneumothorax into a satisfactory pneumothorax, and if you succeed in doing that, as far as the technical procedure is concerned, the operation is successful. The results and the complications from then on are those of pneumothorax, and I do not think that the operation, per se, greatly increases the complications of pneumothorax without pneumonolysis. This certainly has not been my experience.

I am not prepared to give any figures on pneumothorax, but all of you know that pneumothorax has certain complications inherent in the procedure itself. They are both immediate and late. There are also many failures of pneumothorax to close a cavity when there are apparently no adhesions whatsoever.

The question of the technique of this operation depends upon the individual preference of the operator.

I remember very distinctly that thirteen years ago Dr. O'Brien said it was a terrible operation, and until he designed his own instrument which was satisfactory to him, it was awful. I happened to be one of those who designed an instrument that is satisfactory to me, and I do not believe Dr. O'Brien is as ambidextrous as he looks to be when he does a thoracoplasty.

DR. LOUIS R. DAVIDSON, New York, N. Y.—I do not intend to repeat what both Dr. Welles and Dr. Moore have already stated to you. Dr. Day's presentation was well catalogued but his interpretation, perhaps, has been incorrect. There are just a few points I should like to make.

Eighteen years ago I happily devised the first commercially produced single cannular thoracoscope and, in my state of ignorance, was quite pleased with it. At that time Dr. John Alexander said to me, and I disagreed with him, "You are merely looking about and have a prehensile hand at your forehead." In that I described this instrument and its virtues, I owe it to the profession, now that I have abandoned the instrument, to tell them so and the reasons why I have gone over to the double cannular technique.

I believe one of the reasons why Dr. O'Brien and his group do not disinsert adhesions, thereby limiting the opportunity of many patients, is that they still use a single cannular instrument. All of these single technique devices limit the field of vision. In addition, the manipulation of the instrument in the field of the attachment of the adhesion is narrowed. Endothoracic disinsertion cannot be performed. In this connection I recommend the paper of Dr. August Maurer which appeared about fourteen years ago in Brauer's *Beitrage*.

In general, an x-ray does not tell you which patients can, and which cannot be operated upon. Only when one looks into the pleural space, and then sometimes with difficulty, can he tell which adhesions can be severed or disinserted.

The A.C.M.I. is coming out with a new, improved instrument which is devised by Dr. Irving Sarot. It has a magnificent field of vision and is of the double cannular type. It is basically the original Jacobeus instrument with modifications permitting easier manipulation and surer surgery.

I firmly feel there is only one type of instrument to be used in the Jacobeus operation notwithstanding the fact that eighteen years ago I very specifically advocated the single cannular instrument. Only with the double instrument can disinsertions be safely performed.

In addition, the field of vision is more extensive. Finally, I should like to say that with a double cannular instrument the complications are fewer and that is because the pathology is more exactly and distinctly visualized.

DR. E. J. O'BRIEN, Detroit, Mich.—Dr. Day, I think, expressed very clearly at the start of his paper that he thought it was wrong to evaluate the earlier and not the end results following lysis. We wanted to know what happened to these patients. There were a thousand of them done during the period from 1940 to 1947 and a large number before, but we wanted to know the eventual outcome of the treatment with our present technique.

Naturally this operation is in combination with pneumothorax and every time I think of pneumothorax I think of a Boston bull I used to have. He was a wonderful dog when he started out, but he started to develop messy habits, and got so bad we had to shoot him. That is about the way with pneumothorax, unwisely started and continued after complications arise. If pneumothorax alone becomes unduly messy it follows that this procedure with added lysis can be expected to come to the same bad ending if carried on blindly.

We wanted to know whether we had been right in doing these pneumonolyses or whether we should have done more and more thoracoplasties; I think the statistics given in this paper will warrant the conclusion that we should have. We are now doing many more thoracoplasties and quite frequently do a primary one without attempting pneumothorax at all.

Dr. Day also showed that our bad results were in direct proportion to the extent of the disease. That is why we hesitate to cut extensive adhesions, overextensive disease, but would prefer to give up the pneumothorax and do a thoracoplasty.

Drs. Davidson and Moore have apparently missed a good bit of the paper. We do not admit a high mortality from the procedure itself, but have shown what happened to those patients later on. The paper made that quite clear. You do a pneumonolysis on a patient because you want him to get well not just to survive the operation. We have told you how many became well and how many had trouble, and what the trouble was. I think our interpretation of empyema was a very broad one—anything from a little cloudy fluid, upward. Those papers that present lower figures on this complication are often open to question, because it is the individual's own interpretation of empyema.

I do not know just how Drs. Davidson and Moore have come to the conclusion that their instrument is better than mine, or mine is inferior to theirs. They have not seen mine. Now the scope that Davidson is talking about—I tried that too—that is why I wrote the article on open pneumonolysis years ago. I could not see anything through it. You can see with our scope, and you can cut any adhesion that can be cut with any other instrument. Why you should use the chopstick method of Jacobaeus or its modifications, I would not know.

DR. J. CLAUDE DAY, Detroit, Mich.—Perhaps the figure showing the fatality rate is somewhat misleading. It does not mean operative mortality. It refers simply to the percentage of the entire group of patients who died from any cause at some time during a period of observation of from six months to seven years. The operative fatality is clearly indicated.

We have not discussed the indications for pneumothorax though we are well aware of their close relationship to the indications for pneumonolysis. The latter are predicated on an original sound indication for pneumothorax.

It is not our intention to indicate that pneumothorax was used as a measure of choice in acute exudative and pneumonic types of disease. We are in agreement with the majority of opinions that pneumothorax is contraindicated in such lesions except for the occasional instances in which it is used to control pulmonary bleeding.

As regards the type of instrument, we prefer the single portal of entry with the combined cautery and telescope in one unit. It is quite likely that with experienced operators the results will be much the same regardless of the type of thoracoscope used. We do feel, however, that the original Davidson-Cutler thoracoscope is wholly inadequate to the task and

indeed is dangerous because of the extremely limited field of vision afforded. We used it before Dr. O'Brien's modification was available and were never satisfied with it.

My experience with the double portal type of instrument of the Coryllos type while in the Navy, though not large, was sufficient to convince me of the superiority of our type of thoracoscope.

Several instances could be cited of men who were trained to use the Jacobaeus method and who since have had the opportunity to use ours. They have indicated a preference for the latter.

Though we are not in a position to prove it statistically, it is our feeling that the electrosurgical method has many advantages over the galvanocautery and should be used even though a separate trocar wound is used for its introduction into the chest.

We feel definitely that in large peripherally placed cavities suspended by dense adhesions, pneumonolysis is contraindicated. The occurrence of large bronchopleural communications as a result of necrosis of cavity walls with the development of rapidly fatal severe pleural infections is familiar to all. Such a disastrous sequence occurring soon after operation readily establishes the causal relationship of the latter. However, the establishment of late fistulous communications at a more remote period following operation does not indicate that the pneumonolysis can be exonerated completely as a causal factor. In view of the high incidence of pleural complications to be anticipated in these lesions and of the difficulties often encountered in effecting closure, if pneumonolysis does provide a free space, we have felt that the indications for pneumothorax and pneumonolysis should be appreciably restricted.

# PRELIMINARY ANTERIOR CHONDROCOSTECTOMY COMBINED WITH CLOSED CAVITY DRAINAGE AND POSTERIOR THORACOPLASTY

EDWARD S. WELLES, M.D., SARANAC LAKE, N. Y., AND
JOSEPH GORDON, M.D., RAY BROOK, N. Y.

THE problem being considered is collapse of large or so-called giant tuberculous pulmonary cavities. Among thoracic surgeons it is accepted that thoracoplasty is still the most satisfactory method of treating advanced tuberculosis. During the past several years a large amount of work has been done on lung resection. For a while it seemed that removal of a diseased lobe, or the whole lung, might be a better way of treating the disease and that resection might supplant thoracoplasty as the operation of choice. As more reports have come in, giving the immediate and especially the late results of this treatment, early enthusiasm has changed. The majority of the members of the American Association for Thoracic Surgery seem to be in agreement that resection should be reserved for certain types of cases or used when thoracoplasty has failed. In the usual case for surgical collapse with one or more moderate-sized cavities, thoracoplasty results in their closure and sputum conversion in a high per cent. However, in the past many years, it has been found that in these giant cavities, though greatly reduced in size by thoracoplasty, a small triangular or slitlike remainder persisted when the operation was finally completed. Despite this, the patient was very apt to make a satisfactory recovery and become clinically well except for the fact that he still raised a certain amount of positive sputum.

In 1927 one of us (E. S. W.)[1] described an accessory anterolateral operation done through an axillary incision. After failing to close large cavities completely with the standard posterior thoracoplasty, removal of remaining anterior segments of ribs and parts of costal cartilages, sometimes succeeded in closing these cavities. As time went on, it was found that this accessory operation usually further reduced cavity size but did not close it, and therefore failed to convert the sputum. Revision operations in our hands have been found difficult and dangerous, and also failed to close remaining cavities in a large percentage of cases. Serious thought has been given over the last several years to this problem of the uncollapsible cavity which was described somewhat pessimistically by one of us (E. S. W.)[2] in 1936.

After variable experience with Monaldi cavity drainage, which in the majority of cases did not work alone, it seemed that if it could be combined with thoracoplasty, the desired result might be obtained. Here, however, a technical difficulty arose. If the Monaldi tube were inserted anteriorly into the cavity through the first or second interspace, the tube might be encountered

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during posterior or anterior thoracoplasty and serious wound infection would result. A plan was therefore devised to precede cavity drainage by a preliminary anterior stage in which the cartilages of the first three ribs were removed along with bony portions to about the midaxilla. The Monaldi tube could then be put in and the posterior thoracoplasty done without coming in contact with the tube.

With this plan in mind, operations on the first few cases of giant cavity were started. The technique of anterior thoracoplasty is not new, it was described by Wangensteen[3] and was also illustrated in Alexander's book (1937).[4] Following the anterior stage a distinct diminution in the size of the cavity was seen. As this plan was tentative and experimental, it was decided to go ahead with the first posterior stage before putting in the tube. There followed such marked collapse of the cavity that it was decided to postpone drainage once more and do the second posterior stage. In the first six cases done by this method complete closure of cavity resulted, and it was felt that the answer had been obtained. Disappointment followed, however, and the next case that was done resulted in the old type of failure. A long, cigar-shaped cavity was left which continued to produce a large amount of sputum. It was decided to put a Monaldi catheter into this remaining cavity and apply suction. Unfortunately, it was found that this could not be done. Two attempts were made to introduce the catheter but the cavity was so narrowed and lying so close to the aorta that both attempts had to be abandoned. Since that time a number of cases have been done by following the original plan. The drainage tube has been inserted about ten days to two weeks following the anterior stage. Suction has been started and two weeks or so later the posterior stage has been done and others followed in regular order, as needed. Thus far, all of these patients have obtained cavity closure. In some the tubes have already been removed, the sinus tracts have healed, and the cavities thus far have remained closed. Others are still on suction. It is hard to decide just how long the tube should be left in. Probably when the drainage becomes very scant, the bronchial fistula closed, and no evidence of cavity can be seen in x-ray examination, the tube should be removed. It would be preferable if all of these patients could be treated without Monaldi drainage. Introduction of the tube, if done when the cavity is still large, is usually simple and easy. The aftercare of the tube and the suction apparatus is a considerable nuisance to the patient and the nursing staff. We can see no way of predicting which cases will close without Monaldi drainage and which will fail. If one guesses wrong and waits until failure has occurred to put in the tube as a last resort, it may be impossible to do so.

Several incisions and approaches have been previously described for the anterior thoracoplasty and were given in detail by Alexander.[4] It is believed that the incision employed here gives maximum exposure for the removal of the first three cartilages to the sternum. A curved incision is used extending from the sternal end of the first rib, across the second cartilage, along the second interspace, and upward to the axillary fold (Fig. 1, A).

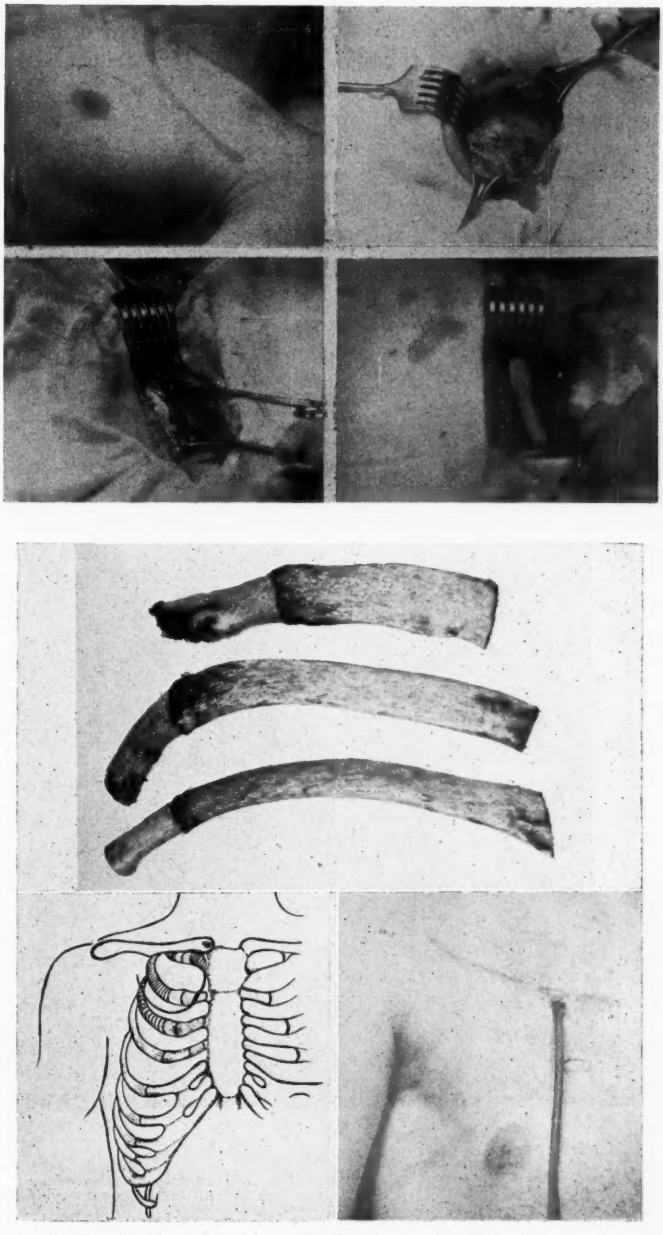


Fig. 1.—*A*, Showing line of incision. *B*, Showing pectoralis major muscle retracted after being divided in direction of fibers and pectoralis minor muscle retracted laterally, exposing second rib. *C*, Showing perichondrium partially peeled from cartilage. *D*, Showing rib freed of both perichondrium and periosteum, ready for resection. *E*, Lengths of resected ribs. *F*, Schematic drawing showing curved line of incision. Dotted area showing extent of resection by Wangensteen and co-workers. This, plus hatched area of first three ribs, but none of fourth rib are removed through incision shown. *G*, Photograph showing healed incisional scar and drainage tube in situ.

The pectoralis major muscle is split in the direction of its fibers, and the pectoralis minor muscle retracted laterally (Fig. 1, B). Resection is begun with the second cartilage. Because of its intimate attachment and thickness, the perichondrium is best "peeled" from the cartilage rather than scraped off. The perichondrium is incised in the axis of the rib, care being taken not to cut too deeply as the cartilage will chip and make removal of the

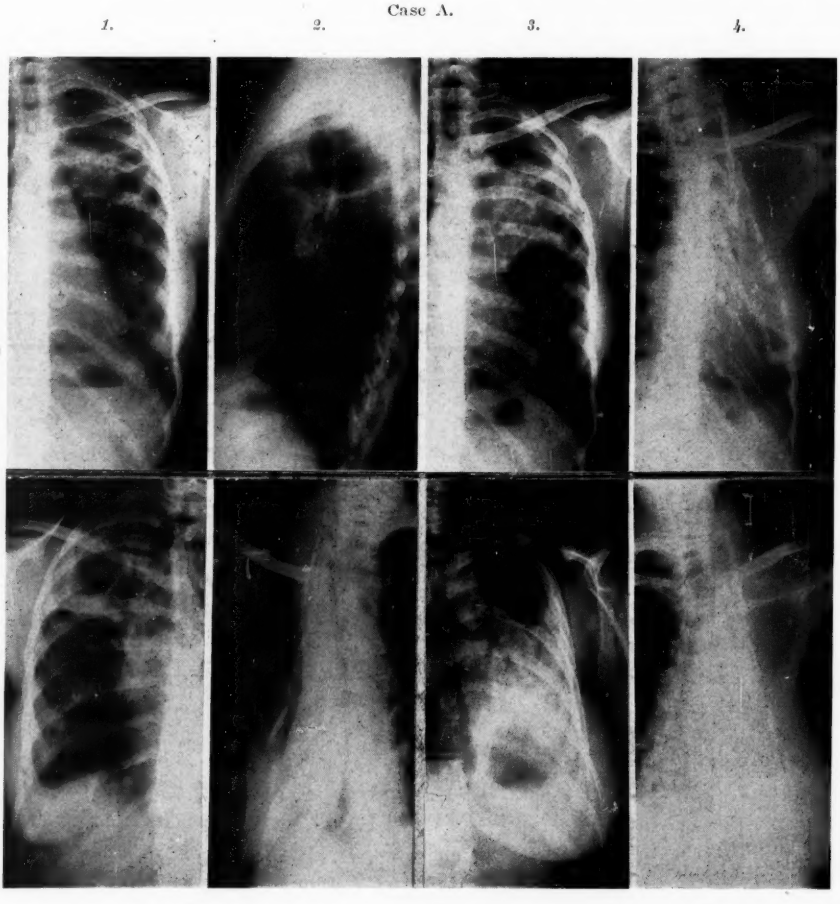


Fig. 2.—Case A, Treated without cavity drainage. (*1*) Preoperative posteroanterior film showing giant cavity in left lung. (*2*) Preoperative left lateral film showing giant cavity in left lung. (*3*) Following anterior thoracoplasty some decrease in cavity size. (*4*) Film showing completed thoracoplasty; patient asymptomatic and sputum negative; discharged.

Case B, Treated without cavity drainage. (*1*) Preoperative posteroanterior film showing giant cavity and extensive disease in right lung. (*2*) Postoperative film, surgery completed; patient clinically well and sputum negative; discharged.

Case C, Treated without cavity drainage. (*1*) Preoperative posteroanterior film showing giant cavity and completely useless left lung. (*2*) Postoperative film, surgery completed; clinically well, sputum negative; discharged.

perichondrium difficult. Near each end of the cartilage a transverse incision is made to facilitate lifting the perichondrium with a blunt-ended elevator (Fig. 1, C). After the cartilage has been freed of perichondrium the remaining bony segment to the midaxilla is scraped free of periosteum (Fig. 1, D) and the rib sectioned in the usual manner. Segments of the first and third ribs are then removed in that order. It is only occasionally possible to remove

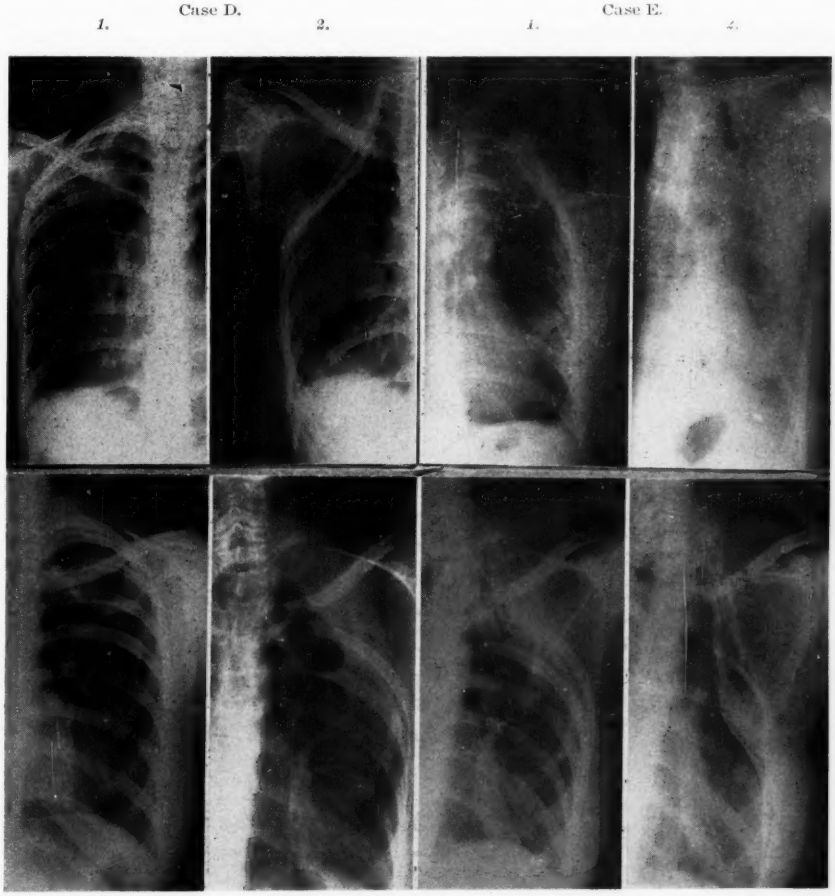


Fig. 3.—Case D, Treated without drainage. (*1*) Preoperative film showing large cavity, and disease through right upper lobe. (*2*) Postoperative film, surgery completed, patient clinically well, sputum negative.

Case E, Treated without drainage which was attempted after failure of cavity closure. (*1*) Preoperative film showing giant cavity and extensive disease in left lung. (*2*) Postoperative film showing residual cavity slit adjacent to aorta.

Case F, Treated with drainage after anterior and first posterior stages. (*1*) Posteroanterior film showing giant cavity. (*2*) Posteroanterior film following anterior and first posterior stage, cavity little changed. (*3*) Film following introduction of drainage tube and cavity markedly reduced. (*4*) Film after surgery completed, tube removed, sinus healed; patient well, sputum negative, and working part time as nurse.

the first rib intact (Fig. 1, E). Most often, it is best removed piecemeal with a small rongeur after stripping perichondrium and periosteum from it. The sternal marrow is regularly exposed at this time. It is common to see a freely moving lung beneath the pleura, as most of the disease is in the posterior part of the lung. Great care must be exercised to avoid injury

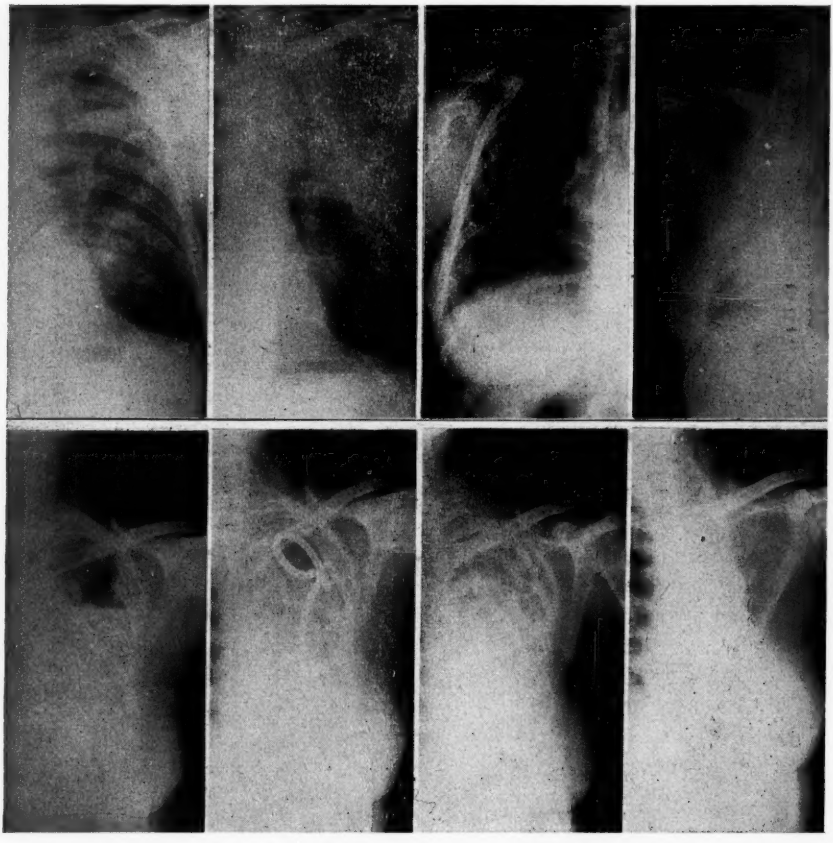


**Fig. 4.—Case G, Treated with drainage. (*1*) Posteroanterior film showing giant cavity and extensive disease in left lung. (*2*) Postoperative film, surgery completed; patient asymptomatic, no sputum raised; postoperative convalescence being completed (note slitlike shadow is not cavity).**

**Case H, Treated with drainage. (*1*) Preoperative film showing giant cavity. (*2*) Postoperative film, surgery completed, catheter removed, sinus tract healed; patient clinically well and completing postsurgical convalescence.**

**Case I, Treated with drainage. (*1*) Preoperative film showing giant cavity, useless lung, and evidence of previous operation by regenerated ribs; Maximum breathing capacity 43 liters. (*2*) Film after anterior stage (first two ribs) and cavity drainage established. (*3*) Film after first posterior stage (first two ribs), catheter nonopaque. (*4*) Film after completed surgery, catheter removed, sinus healed, patient clinically well, sputum negative; completing convalescence.**

to this tissue-paper thin pleura. Rib resection should be back far enough, not only to facilitate the posterior stage, but also to avoid the cavity drainage tube which will have been previously introduced between stages. The wound is drained with a Penrose tube and closed in layers. A firm, compressive dressing is then applied to aid in limiting paradoxical movement of the chest. The drain is removed in forty-eight hours.

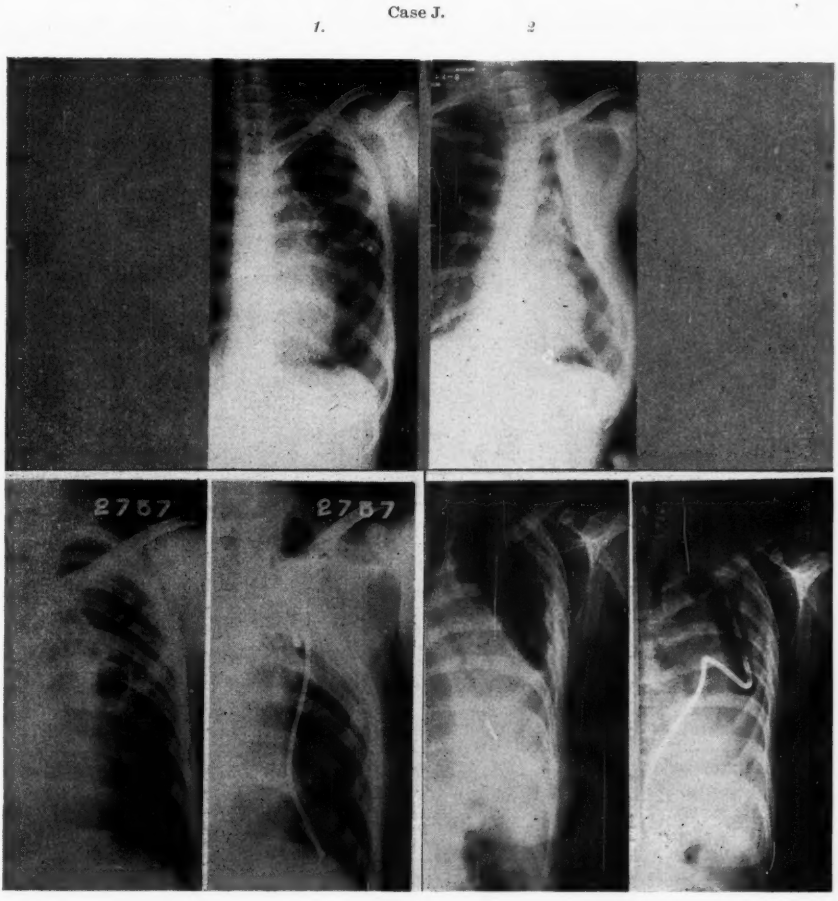


Fig. 5.—Case J, Treated without drainage. (*1*) Posteroanterior film showing giant cavity. (*2*) Postoperative film surgery completed, patient clinically well; discharged and working as housewife.

Case K, Treated with drainage. (*1*) Preoperative film showing giant cavity and extensive disease through left lung; patient acutely ill. (*2*) Film following anterior stage, cavity drainage and one posterior stage; cavity reduced to slit, patient markedly improved; surgery to be completed.

Case L, Treated with drainage. (*1*) Preoperative film, showing giant cavity, useless left lung; patient acutely and seriously ill. (*2*) Film following anterior stage and cavity drainage, marked reduction in size and great symptomatic improvement.

The posterior stage is greatly facilitated, and after stripping the remaining posterior segment of rib of its periosteum and sectioning it from behind, the anterior end is freed by simply lifting it out. Frequently, a segment of the fourth rib is removed at the first posterior operation. Extrafascial or extrapleural apicolysis is not employed, but the first and second intercostal muscle bundles are routinely severed posteriorly and allowed to drop down over the collapsing lung. The anterior chest wall has, in each instance, developed sufficient stiffness postoperatively so as not to be a problem in paradoxical movement.

The patients all had far-advanced disease according to the National Tuberculosis Association classification. The distribution was most often bilateral and it was perferred to have the contralateral disease in the quiescent or stable phase. All had positive sputum and many raised copious amounts of thick, purulent secretions. A number had bronchial disease, as noted by bronchoscopy. Though studies of respiratory reserve were not often made on these ill patients, it was estimated clinically that adequate functional pulmonary reserve was present considering the extent of lung to be collapsed. The anterior operation was well tolerated because of minimum blood loss, absence of any shock, and minimum of tissue trauma. For this reason the older aged group (sixth decade and over) was similarly treated without cavity drainage.

Some very sick patients for whom in the past thoracoplasty was considered too hazardous have been operated upon by this plan. With the establishment of cavity drainage and all of the previously reported advantages of the Monaldi operation (diminished expectoration, reduction of fever, general symptomatic improvement), it has been possible to carry these patients through their thoracoplasty operation. In dealing with such a poor type of case, a certain mortality must be expected. However, in reviewing the few patients who have died, it would seem that in each instance we were overenthusiastic in accepting them for surgery. A statistical analysis is not given at this time because (1) the series is too small for significance and (2) the follow-up period is too short. It must be stated, however, that the results thus far obtained warrant the further use of this plan. It was originally planned to give a brief summary of a number of typical cases at this point, but the illustrations speak for themselves and the clinical histories are omitted.

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DISCUSSION

DR. W. A. HUDSON, Detroit, Mich.—In 1931, I presented before this group what I termed an anterior stage thoracoplasty, to be done as a primary procedure

in the management of giant cavities, giving what I thought, at the time, were acceptable reasons for doing the anterior stage.

We demonstrated the extent or length of the rib that can be removed and the marked collapse of these giant cavities that can be obtained by the resection of a limited number of ribs, anteriorly. It is possible, at an anterior operation, to remove the complete length of the first and second rib, disarticulating them at the corresponding transverse vertebral processes.

Since 1931, we have made the anterior stage the first operation to be done in a majority of the thoracoplasties, which we have done. We have found that the collapse is much more satisfactory, and we are permitted to limit the thoracoplasty to a fewer number of ribs when we undertake to do the posterior resection.

Now, in the cases that Dr. Welles has presented, I am impressed by two points: (1) Some of the giant cavities that he is dealing with are, I am convinced, tension cavities, and if the tension could be relieved, the magnitude of the cavity would, of course, be reduced. (2) A decision should be made as to whether or not one can anticipate a satisfactory closure of the cavity by the thoracoplasty without further intervention, or whether it will be necessary to introduce a tube in order eventually to obliterate the cavity. In those cases in which it is thought that it might be possible to close the cavities and convert the sputum by the thoracoplasty, I would perfer that the first stage anterior thoracoplasty be followed by the routine posterior resections, but in those cases in which suction drainage is contemplated, I would prefer to introduce suction, following later with a cavernostomy.

Dr. Welles has told us that he has not removed the tubes in all of these cavities. He says that he thinks eventually he can remove the tubes, and hopes that they will be all right.

At one of the meetings, soon after suction drainage was first introduced in this country, it was brought out that the cavity would, in a great percentage of cases, become reinfected because of contamination through the open bronchus, and open up again. In most such cases, in my own hands, they have required secondary operations at some later date because of reinfection of the residual cavity. I think the giant cavities that have been treated by suction should be cleaned up by a cavernostomy, something of the type that was presented at this meeting last year.

The incision that Dr. Welles has exhibited is a little different from the incision I have used. The line of the incision that I use extends from a point just medial to the head of the humerus and downward and medialward to the junction of the second costal cartilage with sternum. This affords ample exposure for a generous resection of the ribs.

Dr. W. L. Rogers, San Francisco, Calif.—I believe this subject is important to all of us dealing with tuberculosis.

Dr. Welles has combined the two principles of decompression with external drainage and extensive apical collapse.

In view of the fact that in this particular group of cases under discussion the amount of caseation and fibrosis of the lung parenchyma is usually minimal, and bronchial disease may be playing an important role in maintaining the large cavity, we have of recent date used streptomycin preoperatively and postoperatively in conjunction with collapse therapy. Our results to date have been encouraging, and we hope this combination may obviate at least to some extent the necessity of cavity decompression and drainage either initially or later.

We all appreciate, I am sure, before evaluating surgical procedures for tuberculosis, especially in the presence of tension cavities, that considerable time must elapse before final evaluation may be made.

I would like to ask Dr. Welles if they supplemented streptomycin therapy in this group under discussion either systemically or locally into the cavities after drainage had been established.

DR. WARRINER WOODRUFF, Saranac Lake, N. Y.—I should like to substantiate what Dr. Welles has said. However, this is not an entirely new procedure.

Three years ago, before the meeting in Chicago, Dr. Head presented a paper on intracavitary (Monaldi) suction, and he gave as one of his indications, the reduction in size of extremely large excavations as a preliminary to thoracoplasty. It is this group that Dr. Welles has discussed today.

At that time we reported six instances of Monaldi followed by thoracoplasty. Since that time, Kelley, Merkel, and I have had an additional twelve. We have several others where Monaldi suction has been done and we hope to follow with thoracoplasty.

There is one point that Dr. Welles has made in the abstract—and again this morning—which I think is most important to get closure of the cavities, namely, do not wait until after the anterior ribs have regenerated before starting a posterior stage. Unfortunately, we have done that in several instances. Many of the candidates for Monaldi suction are so ill that thoracoplasty seems inadvisable. Sometimes it is only after months of drainage that they are in condition for thoracoplasty and by then rib regeneration has occurred. This has been a cause of failure to close cavities with us, so I urge that the posterior stage be done as quickly as possible following the insertion of the catheter.

The other point which I think is very important, as Dr. Welles brought out, is the extent of ribs which it is necessary to take anteriorly. The longer the anterior length, the better the original collapse, and the less likelihood of breaking into the sinus tract at the posterior stage. We have had one instance where, at the posterior stage, we opened into the sinus tract, with the catheter in place. We closed the wound and left the catheter in place, and no infection developed. We and the patient were very fortunate.

In some instances where the anterior section was not long enough, we have even left a small section of the rib anteriorly, just to avoid breaking into that sinus tract.

DR. EDWARD S. WELLES, Saranac Lake, N. Y.—I should like to say to Dr. Hudson that our experience with cavernostomy has not been very pleasant, and we like to do anything to avoid it.

He said that some of the tubes are not yet out, and asked if the cavities remain closed, when they do come out. I do not know, except that in all the ones that we have finished to date, from which we have taken the tubes, the cavities have remained closed, and the sinuses have healed.

I think with the combined thoracoplasty, on top of the tube, when we take it out, the cavity will close and not reopen the way the old Monaldi type did, which did not have a thoracoplasty.

Streptomycin has been used for some of these patients preceding and along with the operation, and some of them are taking it right now. We have not instilled streptomycin into the cavities. On the contrary, we have taken it out. That is we have taken cavity drainage in a bottle to the laboratory and had it tested, and found plenty of streptomycin in it. So as long as it is coming into the cavity from the inside, we have not put any in from the outside.

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## Erratum

In the article by Sommer, Jr., and O'Brien entitled "War Wounds of the Esophagus" in the June, 1948, issue of the JOURNAL, Figs. 1 to 4 should be assigned to Case 2 rather than to Case 1.

# The American Association for Thoracic Surgery

## 1948-1949

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## REPORT OF MEETING OF THE AMERICAN ASSOCIATION FOR THORACIC SURGERY

### May 31, June 1 and 2, 1948

THE twenty-eighth meeting of the American Association for Thoracic Surgery was held in Quebec, Canada, at the Chateau Frontenac, on May 31, June 1 and 2, 1948.

The amendments to the Constitution, which were read at the meeting in 1947, were acted upon and passed. They were as follows:

> Article IV, Section 1. There shall be four classes of members—Active, Associate, Senior, and Honorary. Admission to membership in the Association shall be by election. There shall be no numerical limits on any class of membership. Only Active and Senior members shall have the privilege of voting or holding elective office.
>
> Article IV, Section 2. Election to all classes of membership shall be for life, subject only to the provisions of Section 3, which deals with resignation and/or expulsion for cause.

The Association voted to accept the proposals of the American Board of Surgery for the establishment of a subsidiary Board of Thoracic Surgery. The principles involved in the establishment of the Board of Thoracic Surgery, as reported by Dr. Carl Eggers, Chairman of the Committee which negotiated with the American Board of Surgery, were accepted by the Association.

The establishment of a Founders' Group will be at the discretion of the Board of Thoracic Surgery. Dr. William M. Tuttle, Detroit, Mich., is secretary of this Board. Complete membership of the Board and other details will be announced later.

The following recommendations of the Membership Committee were accepted by the Association:

Honorary membership was conferred upon Dr. Wolfgang Denk, Vienna, Austria.

The following active members were retired, at their own request, to Senior membership:

Dr. L. Wallace Frank, Louisville, Ky.
Dr. Gabriel Tucker, Philadelphia, Pa.

The following Associate members were elected to Active membership:

Dr. Herbert Willy Meyer, New York, N. Y.
Dr. Carl G. Merkel, Saranac Lake, N. Y.
Dr. Alexander E. W. Ada, New York, N. Y.
Dr. Robert G. Bloch, Chicago, Ill.
Dr. John R. Paine, Minneapolis, Minn.
Dr. Ross Robertson, Vancouver, B. C.
Dr. Daniel A. Mulvihill, New York, N. Y.
Dr. Rollin A. Daniel, Jr., Nashville, Tenn.
Dr. Earl B. Kay, Cleveland, Ohio
Dr. Edward M. Kent, Pittsburgh, Pa.
Dr. Laurence J. Miscall, New York, N. Y.
Dr. Lawrence M. Shefts, San Antonio, Texas
Dr. Edward J. McGrath, Cincinnati, Ohio

The following candidates were elected to Associate membership:

Dr. David Bancroft Aitchison, Mount Sanatorium, Hamilton, Ontario, Canada.
Dr. Oscar Auerbach, 121 Hamden Ave., Staten Island, N. Y.
Dr. Edward Benson Benedict, Massachusetts General Hospital, Boston, Mass.
Dr. George Valter Brindley, Jr., Scott and White Clinic, Temple, Texas
Dr. Robert K. Brown, 806 Metropolitan Building, Denver, Colo.
Dr. Ambrose Sevier Churchill, 1136 West Sixth St., Los Angeles 14, Calif.
Dr. Walter B. Crandell, Veterans Administration Hospital, White River Junction, Vt.
Dr. Forest Dewey Dodrill, 641 David Whitney Building, Detroit, Mich.
Dr. William H. Falor, 623 Second National Building, Akron 8, Ohio
Dr. Alfred Hurwitz, Veterans Administration Hospital, Newington 11, Conn.
Dr. Vincent Michael Iovine, 2500 Que Street, N.W., Washington, D. C.
Dr. Elgie K. Johnson, #1 Hanson Place, Brooklyn, N. Y.
Dr. Rutledge Starr Lampson, 179 Alleyn St., Hartford, Conn.
Dr. Roy George Klepser, 1150 Connecticut Ave., N.W., Washington, D. C.
Dr. James Monroe Mason, III, 1023 South 20th St., Birmingham 5, Ala.
Dr. Elmer Paul Robert Maurer, 827 Union Central Building, Cincinnati 2, Ohio
Dr. Neil MacDonald, Medical Arts Building, Windsor, Ontario, Canada
Dr. John R. McDonald, Mayo Clinic, Rochester, Minn.
Dr. James Francis O'Neill, 32 Roslyn Ave., Glenside, Pa.
Dr. Edward F. Parker, 70 Hasell St., Charleston, S. C.
Dr. John Lawrence Pool, 140 East 54th St., New York, N. Y.
Dr. Willis J. Potts, 707 Fullerton Ave., Chicago 14, Ill.
Dr. Lawrence Arthur Pratt, 10 Witherell St., Detroit 26, Mich.
Dr. Richard Allen Rasmussen, Blodgett Medical Building, Grand Rapids 6, Mich.
Dr. George Parrott Rosemond, 3401 N. Broad St., Philadelphia 40, Pa.
Dr. J. Gordon Scannell, Massachusetts General Hospital, Boston, Mass.
Dr. Paul W. Schafer, University of Kansas Medical Center, Kansas City, Kan.
Dr. Howard Errol Snyder, 103½ East Ninth Ave., Winfield, Kan.
Dr. William Carleton Whiteside, 342 Birks Building, Edmonton, Alberta, Canada
Dr. Julius Lane Wilson, Ochsner Clinic, 3503 Prytania St., New Orleans 15, La.

## NOTICE

The twenty-ninth annual meeting of the American Association for Thoracic Surgery will be held on March 29, 30, and 31, 1949, in New Orleans, La. Headquarters will be at the Roosevelt Hotel.

Requests for hotel reservations should be mailed direct to Dr. Alton Ochsner, 1430 Tulane Avenue, New Orleans 13, La.

Abstracts for presentation of papers for the 1949 meeting must be received for consideration by the Program Committee, on or before Jan. 1, 1949. These abstracts should be submitted in *quadruplicate* and addressed to the Secretary of the Association, Dr. Brian Blades, George Washington University Hospital, 901 23rd St., N.W., Washington 7, D. C. They should not be sent to the Editor. The early date of the 1949 meeting makes it absolutely necessary that these abstracts be received before the deadline date. Abstracts received after Jan. 1, 1949, will not be considered.

Manuscripts for competition in the Rose Lampert Graff Prize should be sent directly to the Secretary of the Association not later than Jan. 1, 1949.

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## REPORT OF THE COMMITTEE ON BOARD OF THORACIC SURGERY

THE question of certification of thoracic surgeons was first discussed by the American Association for Thoracic Surgery in April, 1925, when it received an invitation to send representatives to a meeting of the National Board of Medical Examiners, to be held in Washington, D. C., May 6, 1925. Two delegates were appointed "to consider in a preliminary way the question of certification as to the qualifications to practice the several specialties in medicine and surgery." No definite action resulted from this meeting.

The question came up again in 1936, when the American Association for Thoracic Surgery appointed a special committee to make a study of the training of thoracic surgeons, as well as certification by a National Board. At the 1937 meeting of the Association the report of the Committee was accepted,* and the Association went on record with the following resolution:

> BE IT RESOLVED that the American Association for Thoracic Surgery recognize the American Board of Surgery as the parent organization which should properly be in control of all matters pertaining to the training and certification of surgeons and surgical specialists.
>
> BE IT FURTHER RESOLVED that the American Association for Thoracic Surgery signify to the American Board of Surgery its willingness to cooperate with it, if and when the special certification of thoracic surgeons seems advisable.

It was the hope of the Committee that such a relationship between the American Board of Surgery and a future Board of Thoracic Surgery might serve as a guide for the relations between the American Board of surgery and other surgical specialty boards.

As the result of the rapid growth and importance of thoracic surgery as a specialty during the succeeding years, fostered partly by the war and the attitude of the medical departments of the armed forces and the Veterans Bureau, there developed a demand for a specialty board in thoracic surgery.

The Association took cognizance of this desire of a large part of its membership and in 1945 the president re-appointed the original committee and instructed them to make a study. At the 1946 meeting, held in Detroit, the committee made its report. This resulted in the adoption of a resolution recommending the formation of a Board of Thoracic Surgery. The Association re-affirmed its previous attitude that the Board of Thoracic Surgery be subsidiary to the American Board of Surgery.

Thereupon the president appointed a small committee consisting of Carl Eggers, chairman; Alton Ochsner, and Jerome R. Head to confer with a similar committee appointed by the American Board of Surgery, as follows: Nathan Womack, chairman; Isaac A.

*THE JOURNAL OF THORACIC SURGERY 7: 347, 1938.

Bigger, and Edward D. Churchill. All important questions dealing with the organization of a Board of Thoracic Surgery were discussed by these committees in joint session and incorporated in a report recommending the formation of such a board.

The necessary formalities with the Advisory Board for Medical Specialties were complied with. The Advisory Board approved the petition of the American Association for Thoracic Surgery and recommended that the American Board of Surgery take the necessary steps to arrange for the certification of thoracic surgeons.

The Committee of the American Board of Surgery informed the Committee of the American Association for Thoracic Surgery of their attitude and made some suggestions about organizing the board. This was made a part of the complete report of the Committee of the American Association for Thoracic Surgery.

At the meeting of the Association for Thoracic Surgery in St. Louis, May 29, 1947, the report was submitted and adopted unanimously, together with some resolutions implementing the report. The president was authorized to continue negotiations with the American Board of Surgery for the organization of a Board of Thoracic Surgery.

For this purpose the president appointed the present committee.

The committee has held two meetings. It has studied the numerous questions involved in the organization of a new board, its relationship to the American Board of Surgery, educational considerations, training requirements, and opportunities for training. It has tried to clarify various questions and on the basis of this study has drawn up the following report, which, if acceptable to the Association, may serve as a guide for the future Board of Thoracic Surgery.

The first question to answer was—What is meant by a surgical specialty board being subsidiary to the American Board of Surgery? Since the establishment of a board of Thoracic Surgery may influence the creation of other subsidiary boards there should be a clear understanding of the relationship of subsidiary boards in general, and of the Board of Thoracic Surgery in particular, to the American Board of Surgery.

In asking to become a subsidiary board of the American Board of Surgery, the Board of Thoracic Surgery undertakes to abide by the rules and regulations, and accepts the constitution and bylaws of the American Board of Surgery. No separate articles of incorporation and/or bylaws are therefore required.

The committee submits its opinion that surgical specialties as well as subspecialties should be developed on a broad education basis, and it therefore believes that candidates for examination in a surgical specialty, and in thoracic surgery in particular, must have had general surgical training and have been certified by the American Board of Surgery.

The committee recognizes the fact that the training of specialists, as advocated by most of the National Boards, is not the only way specialists may be developed. In many instances the requirements appear to be too rigid and have been drawn to favor men with a definite program early in their career. It is recognized that there are many men entering a surgical residency who do not know at the time whether they have special liking or aptitude for a surgical subspecialty. Opportunity may play an important role.

Relatively few of the present leading members of national surgical societies have followed a prescribed rigid course of training. There are many different factors entering into the development of a specialist. It is frequently not until after a surgeon has been practicing for awhile, that he becomes interested in a special subject, or acquires special skill and perhaps has opportunity to develop along special lines. With our present system such a surgeon is excluded from certification by a specialty board.

The important points to remember are that a surgical residency is basic surgical training, which is required of every surgeon who desires certification. Preparation for the practice of a surgical subspecialty, on the other hand, is supplementary to this basic training.

During his residency the candidate should be taught surgical principles; he should rotate through the different surgical specialty departments; he should learn surgical technique and later be allowed to operate independently. In addition he should study the pathologic material of his own cases as well as the basic sciences relating to his subject.*

*See article on Basic Science Instructions in Hospital Residencies, J. A. M. A. 133: 687, 717, 1947.

Except in every large hospitals having separate specialty departments the surgical material of a general hospital service may be fairly evenly distributed and include abdominal, thoracic, urological, traumatic, gynecological, plastic, and neurological surgery. One or the other may predominate. With such a variety of material there may be little opportunity to develop a liking for, or skill in, any particular subspecialty. At the end of his residency the candidate finds himself to be what is called a general surgeon.

Although this has given him the general training he desires, it has up to this point deprived him of the opportunity of becoming a specialist in any branch of surgery, should he so desire.

It is only the man who knows early in his career that he favors a subspecialty who may arrange his course to include in his general surgical residency a period of training in a specialty as provided in the *Booklet of Information* of the American Board of Surgery, June, 1945, as follows:

> The Board requires that three years of the five-year period must be in the general surgical field. A maximum of two years credit will be allowed for work in certain fields that are closely related to general surgery, such as thoracic surgery, plastic surgery, cancer surgery, orthopedics and gynecology. No credit is allowed for special training in the more highly specialized fields such as eye, ear, nose and throat.

The regulations of the American Board of Surgery published in August, 1947, read as follows:

> Candidates who have the following requirements will be eligible for consideration by the Board:
>
> *Group I.—Four years of education in surgery in a graded residency in one or more institutions. The training programs of hospitals must be approved by an appropriate Committee of the Board, in addition to the approval of the hospital for graduate training by the Council on Medical Education and Hospitals of the A.M.A., or the American College of Surgeons. One year of the four may be in a sub-specialty of surgery, such as thoracic, plastic, cancer, orthopedics, proctology, or gynecological surgery. If the second year of a two year internship is surgical and in a hospital approved for graduate training, it will be acceptable on the above four years.

*A graded residency includes a period of training in which the trainee has increasing responsibility for the care and management of surgical patients. Adequate operative experience in which the candidate has assumed the whole responsibility will be required.

> †Group II.—In lieu of the requirements for Group I, the board will continue to accept, for the present, three years of acceptable residency training, followed by two years of study or practice of surgery. The latter two years may be taken under one certified by the Board and acceptable for this purpose to the Board and carrying on his practice in hospitals fully approved as meeting the minimum hospital requirements of the American College of Surgeons.

†An acceptable residency is one approved for graduate training in surgery by the American College of Surgeons or the Council of the A. M. A.

Each candidate must have three years' acceptable training in general surgery. It is desirable that the three years of acceptable residency training of Group II applicants precede the two years allowed in the study or practice of surgery, although this is not essential. Not more than two of the five years required of Group II applicants may be spent in the subspecialties of surgery, such as those listed above.

Inasmuch as the Board of Thoracic Surgery requires two years of training in its subspecialty before the candidate is eligible for examination, it follows that there will have to be two distinct examinations. One will be held by the American Board of Surgery, and the second one by the Board of Thoracic Surgery, whenever the candidate has finished his training and is considered eligible.

There will be some men, however, who will develop as specialists more slowly and not as the result of a prescribed training course. Many of our outstanding men in surgery today have developed special skill and aptitude in a subspecialty or sometimes in several subspecialties, without a special training course. It may reasonably be expected that men

will continue to do so and that they may eventually desire certification. Opportunity should be given these men to be examined and certified.

There was one other question requiring elucidation—Where do the functions of the American Board of Surgery end and the functions of the Board of Thoracic Surgery begin? It is no doubt possible for anyone who has been certified as a surgeon to apply subsequently to a surgical subspecialty board for certification, or even to more than one board.

Inasmuch as the subspecialty board sets up educational and training requirements for its candidates, and examines them, it is reasonable to expect that it will also issue the certificate. This would mean that after a subspecialty board is set up with the approval and under the guidance of the American Board of Surgery, it becomes independent so far as certification of its candidates is concerned. It is, however, still bound by the constitution and bylaws of the American Board of Surgery and the latter has the right to approve or disapprove the personnel of the cooperating surgical societies which jointly form the Board of Thoracic Surgery.

There should be close cooperation between the officers of the American Board of Surgery and those of the Board of Thoracic Surgery in order to maintain high standards and to avoid conflict.

PROPOSED PLAN OF ORGANIZATION

1. *Name.*—Board of Thoracic Surgery.

2. *Organization.*—The cooperating national surgical societies selected jointly to form the Board are to be represented as follows:

| | |
|---|---|
| The American Association for Thoracic Surgery | 4 |
| The American Surgical Association | 3 |
| The American College of Surgeons | 2 |
| The Surgical Section of the A.M.A. | 2 |

There should be a rotating term of membership by the stagger system, length of term to be five years. The Board is to elect its own officers. It is suggested that the secretary be elected for a longer, indeterminate number of years.

Each cooperating association has the appointing power of its own representatives, subject to the approval of the Board of Thoracic Surgery and of the American Board of Surgery.

3. *Constitution and Bylaws.*—Same as for the American Board of Surgery.

4. *Qualification Requirements for Applicants.*—

(a) Certification by the American Board of Surgery.

(b) Two years' training in thoracic surgery in institutions approved by the Board of Thoracic surgery, or meritorious contributions to thoracic surgery. One of these two years may be spent during the four years of training in surgery required by the American Board of Surgery.

(c) Written, oral, and practical examination.

5. *Definition of What Is Considered Acceptable Training in Thoracic Surgery.*—To qualify for the examination in thoracic surgery, the candidate shall have had two years of training in an active, well-integrated thoracic surgical clinic or clinics, or the equivalent amount of thoracic surgical training, on a mixed service consisting of thoracic and nonthoracic surgical cases. The training shall consist of adequate preparation in both the tuberculous and nontuberculous aspects of thoracic surgery. In order to attain this objective, combined residencies between institutions of different types may be advantageous. It is also required that the candidate be familiar with the basic sciences as related to thoracic surgery. Under exceptional circumstances certain surgeons may, by virtue of recognized proficiency in the surgical treatment of thoracic diseases, qualify for the examination at the discretion of the Board.

6. *Opportunities for Training—Residencies.*—Answers to questionnaires sent to the members of the American Association for Thoracic Surgery, in 1946, revealed residencies and fellowships in thoracic surgery to be available in fifty-six hospitals. In sixteen additional

institutions training programs were contemplated in the near future. Critical evaluation of these available data indicated adequate residency training in thoracic surgery in at least thirty-five hospitals. Some of these hospitals can accommodate several residents.

A current questionnaire suggests a substantial increase in the number of available satisfactory residencies in thoracic surgery.

It appears that in the future there will be sufficient opportunity for training to allow qualification for the Board of Thoracic Surgery.

7. *Founders Group.*—To be composed of surgeons who have made meritorious contributions to thoracic surgery, as follows:

(a) Active and senior members of the American Association for Thoracic Surgery, who have been certified by the American Board of Surgery, will automatically be founder members.

(b) Other surgical members of the American Association for Thoracic Surgery will have their records reviewed by the Board, and may be recommended for founder membership with or without application.

(c) Other surgeons, certified by the American Board of Surgery, who upon application, and after review of their qualifications, are found to meet the requirements of the Thoracic Board.

The Founders Group will be kept open for two years after organization of the Board.

8. *Group to be Certified by Examination.*—Only candidates who have been certified by the American Board of Surgery are eligible for examination.

The Board of Thoracic Surgery will review the candidate's training or accomplishments in thoracic surgery. If acceptable, he will be notified to appear for examination.

9. *Examinations.*—The Board of Thoracic Surgery will be governed by the rules laid down by the American Board of Surgery pertaining to examinations as well as re-examinations.

Rules may be changed, however, at the discretion of the Board of Thoracic Surgery.

10. *Fees.*—It is suggested that the fees for candidates to be certified in thoracic surgery be as follows:

Founders Group: For those who will be admitted to this group, a certificate will be issued. The fee will be $25.

Group to be Certified by Examination: For the special examination in thoracic surgery and the issuing of a certificate, the fee will be $50. The examination is to be completed in one day. The fee for re-examination will be $25.

11. *Certificates.—Certificates to the Founders Group* are to be issued according to the suggestions mentioned previously, as follows:

(a) To active and senior members of the American Association for Thoracic Surgery, who have been certified by the American Board of Surgery, without examination.

(b) To those surgical members of the American Association for Thoracic Surgery, who are found to be eligible. Application may or may not be required.

(c) To other surgeons certified by the American Board of Surgery, upon application and recommendation of the Board of Thoracic Surgery.

*Certificates to those admitted by examination* are to be issued after the candidates meet the requirements and successfully pass the examinations.

Respectfully submitted by
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